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IDENTIFIERS	DACUM Process; *Electrical Discharge Machines

ABSTRACT

This package consists of course syllabi, an instructor's handbook, and a student laboratory manual for a 2-year vocational training program to prepare students for entry-level employment as tool and die makers. The program was developed through a modification of the DACUM (Developing a Curriculum) technique. The course syllabi volume begins with the MASTER (Machine Tool Advanced Skills Technology Educational Resources) Program Consortium competency profile with 10 duties (and supporting technical workplace competencies): practice safety; apply mathematical concepts; interpret engineering drawings and control documents; demonstrate knowledge of manufacturing materials; measure/inspect; demonstrate knowledge of manufacturing processes; use computers; perform CAD/CAM (computer-aided design/computer-aided manufacturing) and CNC (computer numerical control) programming tasks; perform tool and die making operations; and operate electrical discharge machine (EDM). The first volume contains the justification, documentation, and course syllabi for the courses. Each syllabus contains the following: course description; prerequisites; course objectives; required course materials; methods of instruction; lecture outline; lab outline; Secretary's Commission on Achieving Necessary Skills competencies taught; and appropriate reference materials. The instructor's handbook consists of technical training modules that include some or all of the following: time required; duty; task; objective(s); instructional materials list; references; student preparation; introduction; presentation outline; practical application; evaluation; summary; and attachments, including handouts, laboratory worksheets, and self-assessment with answer key. The handbook is arranged by duty grouping, with technical modules

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developed for each task box on the competency profile. The student laboratory manual contains a DACUM chart and learning modules for duties A-J. Each module in the student manual includes some or all of the following: objectives, outline, laboratory exercises, laboratory aids, and handouts. (KC)

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ED 422 493

Tool & Die and EDM Series
Educational Resources for the Machine Tool Industry
Course Syllabi
Instructor's Handbook
Student Laboratory Manual

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MACHINE TOOL ADVANCED SKILLS TECHNOLOGY EDUCATIONAL RESOURCES

MASTER

a consortium of educators and industry

EDUCATIONAL RESOURCES
FOR THE
MACHINE TOOL INDUSTRY

Tool & Die and EDM Series
COURSE SYLLABI

Supported by the National Science Foundation's Advanced Technological Education Program

MACHINE TOOL ADVANCED SKILLS TECHNOLOGY EDUCATIONAL RESOURCES

MASTER

EDUCATIONAL RESOURCES
FOR THE
MACHINE TOOL INDUSTRY

Tool & Die and EDM Series

COURSE SYLLABI

Supported by the National Science Foundation's Advanced Technological Education Program

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National Science Foundation
Advanced Technological
Education Program

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National Science Foundation - Division of Undergraduate Education
MASTER Consortia of Employers and Educators

MASTER has built upon the foundation which was laid by the Machine Tool Advanced Skills Technology (MAST) Program. The MAST Program was supported by the U.S. Department of Education - Office of Vocational and Adult Education. Without this prior support MASTER could not have reached the level of quality and quantity that is contained in these project deliverables.

MASTER DEVELOPMENT CENTERS
Augusta Technical Institute - Central Florida Community College - Itawamba Community College - Moraine Valley Community College - San Diego City College (CACT) - Springfield Technical Community College - Texas State Technical College

INDUSTRIES
AB Lasers - AIRCAP/MTD - ALCOA - American Saw - AMOCO Performance Products - Automatic Switch Company - Bell Helicopter - Bowen Tool - Brunner - Chrysler Corp. - Chrysler Technologies - Conveyor Plus - Darr Caterpillar - Davis Technologies - Delta International - Devon - D. J. Plastics - Eaton Leonard - EBTEC - Electro-Motive - Emergency One - Eureka - Foster Mold - GeoDiamond/Smith International - Greenfield Industries - Hunter Douglas - Industrial Laser - ITT Engineered Valve - Kaiser Aluminum - Krueger International. - Laser Fare - Laser Services - Lockheed Martin - McDonnell Douglas - Mercury Tool - NASSCO - NutraSweet - Rapistan DEMAG - Reed Tool - ROHR, International - Searle - Solar Turbine - Southwest Fabricators - Smith & Wesson - Standard Refrigeration - Super Sagless - Taylor Guitars - Tecumseh - Teledyne Ryan - Thermal Ceramics - Thomas Lighting - FMC, United Defense - United Technologies Hamilton Standard

COLLEGE AFFILIATES
Aiken Technical College - Bevil Center for Advanced Manufacturing Technology - Chicago Manufacturing Technology Extension Center - Great Lakes Manufacturing Technology Center - Indiana Vocational Technical College - Milwaukee Area Technical College - Okaloosa-Walton Community College - Piedmont Technical College - Pueblo Community College - Salt Lake Community College - Spokane Community College - Texas State Technical Colleges at Harlington, Marshall, Sweetwater

FEDERAL LABS
Jet Propulsion Lab - Lawrence Livermore National Laboratory - L.B.J. Space Center (NASA) - Los Alamos Laboratory - Oak Ridge National Laboratory - Sandia National Laboratory - Several National Institute of Standards and Technology Centers (NIST) - Tank Automotive Research and Development Center (TARDEC) - Wright Laboratories

SECONDARY SCHOOLS
Aiken Career Center - Chicopee Comprehensive High School - Community High School (Moraine, IL) - Connally ISD - Consolidated High School - Evans High - Greenwood Vocational School - Hoover Sr. High - Killeen ISD - LaVega ISD - Lincoln Sr. High - Marlin ISD - Midway ISD - Moraine Area Career Center - Morse Sr. High - Point Lamar Sr. High -

Pontotoc Ridge Area Vocational Center - Putnam Vocational High School - San Diego Sr. High - Tupelo-Lee Vocational Center - Waco ISD - Westfield Vocational High School

ASSOCIATIONS

American Vocational Association (AVA) - Center for Occupational Research and Development (CORD) - CIM in Higher Education (CIMHE) - Heart of Texas Tech-Prep - Midwest (Michigan) Manufacturing Technology Center (MMTC) - National Coalition For Advanced Manufacturing (NACFAM) - National Coalition of Advanced Technology Centers (NCATC) - National Skills Standards Pilot Programs - National Tooling and Machining Association (NTMA) - New York Manufacturing Extension Partnership (NYMEP) - Precision Metalforming Association (PMA) - Society of Manufacturing Engineers (SME) - Southeast Manufacturing Technology Center (SMTC)

MASTER PROJECT EVALUATORS

Dr. James Hales, East Tennessee State University and William Ruxton, formerly with the National Tooling and Machine Association (NTMA)

NATIONAL ADVISORY COUNCIL MEMBERS

The National Advisory Council has provided input and guidance into the project since the beginning. Without their contributions, MASTER could not have been nearly as successful as it has been. Much appreciation and thanks go to each of the members of this committee from the project team.

Dr. Hugh Rogers-Dean of Technology-Central Florida Community College
Dr. Don Clark-Professor Emeritus-Texas A&M University
Dr. Don Edwards-Department of Management-Baylor University
Dr. Jon Botsford-Vice President for Technology-Pueblo Community College
Mr. Robert Swanson-Administrator of Human Resources-Bell Helicopter, TEXTRON
Mr. Jack Peck-Vice President of Manufacturing-Mercury Tool & Die
Mr. Don Hancock-Superintendent-Connally ISD

SPECIAL RECOGNITION

Dr. Hugh Rogers recognized the need for this project, developed the baseline concepts and methodology, and pulled together industrial and academic partners from across the nation into a solid consortium. Special thanks and singular congratulations go to Dr. Rogers for his extraordinary efforts in this endeavor.

Dr. Don Pierson served as the Principal Investigator for the first two years of MASTER. His input and guidance of the project during the formative years was of tremendous value to the project team. Special thanks and best wishes go to Dr. Pierson during his retirement and all his worldly travels.

All findings and deliverables resulting from MASTER are primarily based upon information provided by the above companies, schools and labs. We sincerely thank key personnel within these organizations for their commitment and dedication to this project. Including the national survey, more than 2,800 other companies and organizations participated in this project. We commend their efforts in our combined attempt to reach some common ground in precision manufacturing skills standards and curriculum development.

MASTER DEVELOPMENT CENTER, TUPELO, MS
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Tupelo Campus

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Manufacturing in Mississippi

Evolving from a previously agrarian economy, the region served by Itawamba Community College now contains a significant industrial base. Approximately 45% of employed adults in the surrounding area work in manufacturing, with the predominant industries including metal-working, machinery, paper products, rubber/plastics, electrical components, furniture, apparel, and wood products. About 35-40% of all manufacturing employees work in the furniture industry. After World War II, several major metal-working companies established branch plants in the Tupelo area, a trend that has continued into the 1990's. Between 1975 and 1980, pressures of competition and technology caused a number of these companies to reconsider their continued presence in northern Mississippi, spurring action by regional economic development organizations to preserve an employment and tax base essential to the community. Many of their economic development initiatives involved the community college, leading directly to the establishment of its Tool and Die Making Technology program and introduction of training in CAD, CNC, robotics, and lasers.

Itawamba Community College

Itawamba Community College (ICC) provides university transfer programs, associate degree career programs, non-credit customized industry training, and continuing education to a rural five-county area in northeast Mississippi. Of the local population of approximately 170,000 persons, 79% are white and 19% black; the student profile at the College roughly mirrors the racial composition of the general population, and a high percentage of students are from low-income households. The mission of the College includes the mandate to provide "educational services which contribute to the needs of new, expanding, or existing businesses and industries and to the training needs of the people." Accordingly, the College's instructional programs are designed with national trends and the needs of business and industry in mind, and the objective of all courses and training is to provide both students and companies with what they need to succeed. The main campus is in Fulton and the vocational-technical campus in Tupelo.

Development Team

- **Project Director:** Don Benjamin, Associate Dean of Career Education, served as program manager and academic coordinator for the MASTER project.
- **Site Coordinator**: Barry Emison was responsible for industrial assessment and skills validation, as well as development of skill standards and course/program materials for the Tool and Die Technology component of the MASTER project.
- **Subject Matter Experts**: Several college academic and technology instructors served as advisors for basic academic competencies, sharing responsibility with Mr. Emison for compiling data from industry surveys and interviews during the skill standards development process. Donald Taylor and Terry Kitchens, Tool and Die Technology Instructors, served as technical advisors for workplace competencies and developed course curricula and program materials. They also served as co-instructors and coordinators for the MASTER pilot program in Tool and Die Technology.

Introduction

MASTER research indicates that individuals working as Tool and Die Makers will preferably have received at least two years of training and education in both academic and technical courses covering tool and die production methods and processes. This training may have been conducted in a vocational institution or college. Our research indicates that a minimum of two years of vocational training will prepare students with entry level skills necessary to begin work as a Tool and Die Maker.

In this two year program, the students progress through a series of courses designed to both educate and train students with knowledge and skills in areas such as manufacturing materials and methods, conventional and CNC machining, computer–aided drafting and design, engineering mechanics and design, computer–aided manufacturing, and tool and die design and maintenance. Students receive a wide range of training which enables them to seek jobs in many different tool and die making areas. The Tool and Die Making Technology Program at Itawamba Community College has been training Tool and Die Makers for many years and works closely with advisory committee members to make sure that the skills being taught are the skills needed in industry. Students who graduate from this course of study receive Associate of Applied Science degrees from Itawamba Community College. The Tool and Die Making Technology Department worked closely with the MASTER staff, made every effort to assist the MASTER staff with research, and currently seek adoption of the recommended MASTER materials for their Tool and Die Making students. The Tool and Die Making Department at Itawamba Community College is recognized throughout Mississippi by large and small manufacturing companies as a premier source for entry–level technicians. Upon graduation, students are able to interpret complex drawings, select the correct materials, and perform all necessary machining processes. The curriculum has been designed to prepare students to enter the workforce as entry–level Tool and Die Makers. Laboratory work is emphasized with actual industrial equipment in order to prepare students for interesting, rewarding work in a wide variety of industries. The Tool and Die Making Technology department has a practical blend of theoretical knowledge and practical application which directly corresponds to modern uses in tool and die making.

After many interviews with practitioners from industry and discussions with educators, managers, supervisors, and others involved with machine–related occupations (specifically tool and die making technology), the **MASTER** Consortium Partners have agreed to present our definition of a tool and die maker as follows:

TOOL AND DIE MAKER - skilled workers who produce tools, dies, and special guiding and holding devices that are used in machining.

This volume contains the justification, documentation, and course syllabi for the courses which we recommend as minimum training for individuals desiring to become tool and die makers.

The first and most important task of the **MASTER** program was the development of a foundation upon which all other works could be built. The **MASTER** Competency Profile is this foundation.

The MASTER Competency Profile

Development of Competency Profiles at each of the **MASTER** sites began with visits to representative companies for the purpose of surveying expert workers within the industry and occupational areas under investigation. Each site began the survey process by asking a subject–matter expert in the targeted technical area, generally a member of its faculty, to employ a modified version of the generally accepted DACUM (Developing A Curriculum) method to categorize the major skills needed to work in the selected occupation. As source materials, the college instructors drew on their professional knowledge and experience of current industry requirements and trends. The initial skill standards developed by the subject–matter experts underwent numerous internal reviews and revisions within each site, assuming final form as a series of structured survey and interview questions designed to elicit a simple yes or no response.

To determine an appropriate survey sample, each site compiled a database of its region's small and medium–sized manufacturers and searched for companies likely to employ workers in the targeted occupational area. The resulting cross–industry samples were sorted further to achieve a balance of technological capability and workforce size; the sample companies within each region were then asked to participate in the project. Willing respondents were scheduled for interviews.

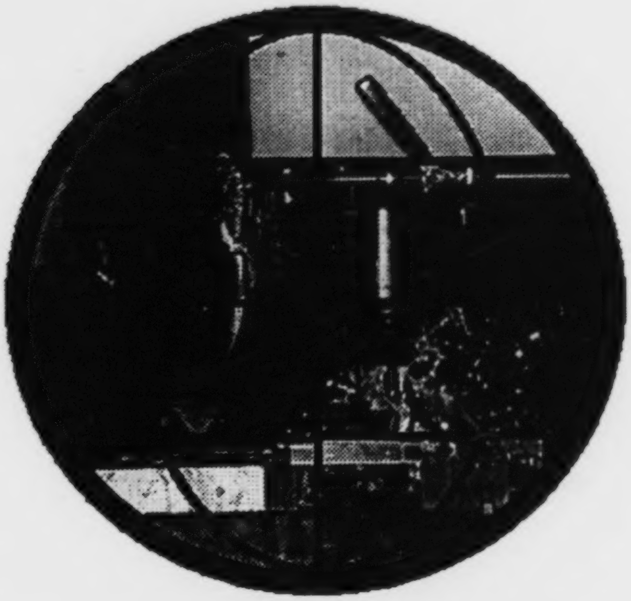
During the company interviews, the **MASTER** staff asked expert workers to identify the primary duties and tasks performed by a typical worker and to consider the special skills and knowledge, traits and attitudes, and industry trends that would have an impact on worker training, employability, and performance both now and in the future. The interview results were analyzed to create individual profiles identifying the most common duties and skills required of workers at each company. These individual company Competency Profiles served two purposes. First, they showed, in a format that could be easily understood by both industries and educators, a picture of the occupational specialty at a given company at that particular time. Second, these individual company Competency Profiles furnished the company with a document over which they could claim ownership. This, in effect, made them real partners in the work of **MASTER**.

Data for all companies were then aggregated to develop a composite Competency Profile of industry skill standards within the selected occupational specialty area of Tool and Die Making Technology, as shown on the following pages.

These same duties and tasks were then included in both the Texas and National Surveys for further validation. As a result of the surveys, additional refinements were made in the Competency Profiles. These changes were incorporated into the individual course syllabi which were used for the pilot program.

The **MASTER** Competency Profile for Tool and Die Maker has been included on the following pages.

Tool and Die Maker
(includes Electrical Discharge Machine)
Competency Profile



Job Analysis conducted and prepared by

MASTER

***M**achine Tool **A**dvanced **S**kills*
***T**echnology **E**ducational*
***R**esources Program*
Consortium

Tool and Die Maker
(includes Electrical Discharge Machine)
Technical Workplace Competencies

Duties	Tasks			
A **Practice Safety**	A-1 Follow safety manuals and all safety regulations/ requirements	A-2 Maintain safe equipment and machinery	A-3 Use safe operating procedures for hand and machine tools	A-4 Maintain a clean and safe work environment
	A-5 Use safe material handling practices	A-6 Consult and apply MSDS for hazards of various materials		
B **Apply Mathematical Concepts**	B-1 Perform basic arithmetic functions	B-2 Perform basic algebraic operations	B-3 Use basic geometric principles	B-4 Perform basic trigonometric operations
	B-5 Use and apply Cartesian coordinate system			
C **Interpret Engineering Drawings and Related Documents**	C-1 Interpret and understand basic layout/ types of drawings	C-2 Interpret, review, & apply blueprint notes, dimensions, & tolerances	C-3 Use and apply Geometric Dimensioning and Tolerancing (GD&T)	C-4 Demonstrate traditional mechanical drafting and sketching techniques
	C-5 Understand and use quality systems			
D **Demonstrate Knowledge of Manufacturing Materials**	D-1 Identify materials with desired properties	D-2 Identify materials and processes to produce a part	D-3 Discuss classification systems for metal	
E **Measure/Inspect**	E-1 Understand metrology terms	E-2 Select measurement tools	E-3 Measure with hand held instruments	E-4 Eliminate measurement variables
	E-5 Measure/ inspect using surface plate and accessories	E-6 Inspect using stationary equipment		

Tool and Die Maker
(includes Electrical Discharge Machine)
Technical Workplace Competencies

Duties		Tasks			
F	**Demonstrate Knowledge of Manufacturing Processes**	F-1 Discuss metal cutting and metal cutting tools	F-2 Operate metal saws	F-3 Operate drill presses and tooling	F-4 Operate engine and turret lathes and tooling
		F-5 Operate vertical and horizontal mills and tooling	F-6 Operate precision grinders	F-7 Operate heat treating equipment and processes	F-8 Operate sheet metal equipment
		F-9 Operate welding equipment and processes	F-10 Estimate time required/cost to produce a part		
G	**Use Computers**	G-1 Use computer operating systems	G-2 Understand computer terminology	G-3 Use file management systems	G-4 Install and use software packages
H	**Perform CAD/ CAM and CNC Programming Tasks**	H-1 Discuss fundamentals of CNC machines and controls	H-2 Program and operate CNC milling machine and machining center	H-3 Program and operate CNC lathe	H-4 Use Computer-Aided Drafting (CAD) system
		H-5 Create 3-D solid models	H-6 Use Computer-Aided Manufacturing (CAM) system		
I	**Perform Tool and Die Making Operations**	I-1 Discuss basic types and functions of jigs and fixtures	I-2 Utilize concepts of jig and fixture design	I-3 Demonstrate understanding of different types of industrial dies	I-4 Utilize basic die theory
		I-5 Utilize principles of die design	I-6 Perform tool and die repair	I-7 Demonstrate tool and die making skills	
J	**Operate Electrical Discharge Machine (EDM)**	J-1 Discuss fundamentals of EDM	J-2 Setup and operate conventional sinker EDM	J-3 Program, setup, and operate CNC sinker EDM and EDM drill	J-4 Program, setup, and operate CNC wire EDM

Tool and Die Maker

(includes Electrical Discharge Machine)

Skills, Traits and Trends

Skills and Knowledge

Communication Skills
Technical Reading/Writing Skills
Ability to Comprehend Written/Verbal Instruction
Leadership Skills
Organizational Skills
Knowledge of Company Policies/ Procedures
Knowledge of Employee/Employer Responsibilities
Ability to Work as Part of a Team
Knowledge of Company Quality Assurance Activities
Knowledge of Safety Regulations/ Responsibilities
Project/Task Management Skills
Logical/Systematic Problem Solving Skills
Computer Skills
Numerical/Mathematical Skills
Use Measurement Tools
Use Inspection Devices
Drafting Skills
Knowledge of Industrial Materials
Knowledge of Manufacturing Processes
Mechanical Aptitude

Traits and Attitudes

Strong Work Ethic
Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Consciousness
Motivation
Responsibility
Physical Ability
Professionalism
Trustworthiness
Personal Ethics
Innovative

Tool/Equipment Proficiency

Machinist's Tools (e.g., calipers, dial indicators, magnetic tool holders, etc.)
Measuring Tools
Metal Layout Tools
Power Tools
Metal Lathe with Attachments
Drill Presses
Vertical Mill with Attachments
Band Saws
Power Drills
Hydraulic/Arbor Press
Heat Treating Equipment
Hardness Testing Equipment
Grinding Machines with Attachments
CNC Machining Center and Turning Center
Jig Boring Machines
Alignment/Calibration Tools
Computer
Ventilation Equipment
Forklift
Personal Safety Equipment
Oxyacetylene Equipment
Tool Storage Equipment
Workbenches
Vises
Pedestal Grinders
Coordinate Measurement Machine

Current Trends

Composites
In-Process Gauging
Rapid Tool Changing
Expanded Communication with Shop Floor
Multi-Axis Equipment
Computer-Integrated Manufacturing
Adaptive Controls
Conversational Programming
Artificial Intelligence

The MASTER Pilot Program
Curriculum and Course Descriptions

After completing the Competency Profile for each occupational specialty area, each **MASTER** partner reviewed its existing curriculum against the industry–verified skill standards in order to identify a suitable foundation for new pilot training programs. Because each college had to comply with the requirements of its respective college system and appropriate state agency, the resulting pilot curricula for occupational specialty areas tended to vary in format and academic requirements (e.g., some programs were based on the semester system, others on the quarter system). Despite differences in the curricula developed at the partner colleges, each of the pilot programs was designed to achieve the following two goals mandated in the **MASTER** grant proposal:

> ***Pilot Program***: "Conduct a one year pilot program with 25 or more selected applicants at each college or advanced technology center to evaluate laboratory content and effectiveness, as measured by demonstrated competencies and indicators of each program area."
>
> ***Student Assessment***: "Identify global skills competencies of program applicants both at point of entrance and point of exit for entry–level and already–employed technicians."
>
> (*Note*: Not all occupational specialty areas were pilot–tested at all Development Centers; however, all partner colleges conducted one or more pilot programs.)

Included on the following page is the curriculum listing for the pilot program which was used to validate course syllabi for this occupational specialty area. The curriculum also shows the number of hours assigned to each of the courses (lecture, laboratory and credit hours). Also included is a description of each of the courses.

MASTER Curriculum
Tool and Die Making Technology
(Associate of Applied Science Degree Program)

		LEC	LAB	CR
First Semester*				
TLD 1016	Machine Tool Technology	3	6	6
TLD 1114	Introduction to Die Making Procedures	2	4	4
DDT 1113	Blueprint Reading and Drawing	2	2	3
CPT 1113	Introduction to Computers	2	2	3
MATH 1233	Applied Mathematics for Engineering Technicians	3	0	3
		12	14	19
Second Semester*				
TLD 1133	Die Design I	2	2	3
TLD 1146	Die Making I	3	6	6
TLD 2713	Computer Numerical Control Operations I	2	2	3
DDT 1313	Principles of CAD	2	2	3
ENGL 1113	English Composition I	3	0	3
		12	12	18
Third Semester*				
TLD 2153	Die Design II	2	2	3
TLD 2166	Die Making II	3	6	6
TLD 2723	Computer Numerical Control Operations II	2	2	3
MATH 1323	Trigonometry	3	0	3
SPT 1113	Oral Communications	3	0	3
		13	10	18
Fourth Semester*				
TLD 2174	Die Making III	2	4	4
TLD 2733	Computer Numerical Control Operations III	2	2	3
TLD 2183	Special Project	1	4	3
	Humanities/Fine Arts Elective	3	0	3
	Social or Behavioral Science Elective	3	0	3
		11	10	16
	Program Totals	48	46	71
Optional Courses:				
TLD 2113	Fundamentals of EDM	2	2	3
TLD 2123	Advanced EDM	2	2	3

MASTER Course Descriptions

Tool and Die Making Technology

(Associate of Applied Science Degree Program)

First Semester

TLD 1016	**Machine Tool Technology** (3-6-6) is composed of fundamental skills related to machine tool operations. Topics covered in the course include safety, precision measurement, blueprint reading, hand and bench work, metallurgy, and the operation of a variety of machine tools.
TLD 1114	**Introduction to Die Making Procedures** (2-4-4) introduces tool and die making procedures including an orientation to metallurgy and die repair. Students are instructed and given practice in the inspection, disassembly, fabrication, and reassembly of die components.
DDT 1113	**Blueprint Reading and Drawing** (2-2-3) prepares students to read and interpret industrial drawings. Emphasis is placed on line identification, abbreviations, symbols, orthographic projection, auxiliary views, sectional views, drafting conventional practices, and sketching.
CPT 1113	**Introduction to Computers** (2-2-3) introduces information processing concepts including operating systems, word processing, spreadsheets, data management, graphics, and BASIC programming.
MATH 1233	**Applied Mathematics for Engineering Technicians** (3-0-3) equips the student with the mathematical skills and knowledge required for complex calculations in the machine tool trades. Emphasis is on the application of common mathematical concepts in a typical shop environment. Topics covered are basic arithmetic functions. Algebraic operations, geometric principles, trigonometric operations, and the Cartesian coordinate system.

Second Semester

TLD 1133	Die Design I (2-2-3) covers the fundamentals of industrial dies and the machining characteristics of die components. This course serves as a continuation of Introduction to Die Making Procedures and Machine Tool Technology. The student is introduced to additional machining skills that will be encountered in typical die shops in the building of dies, jigs, fixtures, and precision machine parts.

TLD 1146	**Die Making I** (3-6-6) continues Introduction to Die Making Procedures with instruction and practice in building a complete functional die from a blueprint. Emphasis is placed on analyzing requirements, managing the project toward completion, and becoming proficient in shop practices and procedures.
TLD 2713	**Computer Numerical Control Operations I** (2-2-3) introduces computer numerical control machines. Includes instruction and practice related to the use of the Cartesian coordinate system, programming codes and styles, and operation of basic CNC machines.
DDT 1313	**Principles of CAD** (2-2-3) uses CAD machines to design and draw various problems in the architectural, mechanical, and civil drafting areas. Emphasis is placed on the operations of the CAD system to solve these problems.
ENGL 1113	**English Composition I** (3-0-3) is a study of grammar and composition, with emphasis on the sentence and the paragraph. The course includes reading and writing frequent themes.

Third Semester

TLD 2153	**Die Design II** (2-2-3) continues Die Design I with more emphasis on actual die design and construction. Stresses the considerations involved in developing die components, such as calculation of clearances, cutting force, and press tonnage requirements.
TLD 2166	**Die Making II** (3-6-6) augments Die Making I with instruction and practice in building a progressive die from a blueprint. Emphasis is placed on the application of the die building procedures learned in Die Making I toward fabricating more complex dies.
TLD 2723	**Computer Numerical Control Operations II** (2-2-3) continues Computer Numerical Control Operations I with additional instruction in writing and editing CNC code manually utilizing more advanced commands and cycles. Additionally, students will be introduced to the use of a Computer–Aided Manufacturing (CAM) system for creation of code.
MATH 1323	**Trigonometry** (3-0-3) studies solutions of right and oblique triangles, identities, trigonometric equations, and polar and parametric equations.
SPT 1113	**Oral Communication** (3-0-3) covers correct and effective English; correct pronunciation; breath control; study and practice in making speeches for all occasions with its major emphasis on organization of material; and practice in speaking before the group.

Fourth Semester

TLD 2174	**Die Making III** (2-4-4) completes Die Making II with instruction and practice in building a compound die from a blueprint. Emphasis is placed on the application of the die building procedures learned in Die Making I and Die Making II toward fabricating more complex dies. Instruction and practice is also given on the use of the Wire Electrical Discharge Machine in the construction of die components.
TLD 2733	**Computer Numerical Control Operations III** (2-2-3) completes Computer Numerical Control Operations I and II with additional instruction and practice in the use of the Computer–Aided Manufacturing (CAM) system for creation of code. Also, the student will be introduced to the Wire Electrical Discharge Machine (EDM) and the Coordinate Measuring Machine (CMM).
TLD 2183	**Special Project** (1-4-3) provides the student with practical application of skills and knowledge gained through other courses in the Tool and Die Technology program. Students will apply material learned in previous and concurrent classes to design, produce, and test an industrial quality die. Emphasis is placed on the students making decisions, setting priorities and time lines, and realizing the overall responsibility of producing a high–quality product in a given amount of time.

Optional Courses

TLD 2113	**Fundamentals of EDM** (2-2-3) is an introduction to Electrical Discharge Machining. It includes instruction and practice in the principles of EDM technology as well as the set–up, programing, and operation of sinker and wire EDM.
TLD 2123	**Advanced EDM** (2-2-3) is a continuation of Fundamentals of EDM Technology with emphasis on 4–axis machining with the CNC wire EDM. Students will be given instruction and practice in the programming of complex parts which utilize the 3rd and 4th axis positioning capabilities of wire EDMs.

The MASTER
Technical Workplace Competencies
and
Course Crosswalk

After development of appropriate curricula for the pilot programs, each MASTER college began to develop individual course outlines for its assigned specialty area. The skill standards identified in the Competency Profile were cross walked against the technical competencies of the courses in the pilot curriculum. The resulting matrix provided a valuable tool for assessing whether current course content was sufficient or needed to be modified to ensure mastery of entry–level technical competencies. Exit proficiency levels for each of the technical competencies were further validated through industry wide surveys both in Texas and across the nation.

The Technical Workplace Competencies and Course Crosswalk on the following pages presents the match between industry—identified duties and tasks, and the pilot curriculum for Tool and Die Making Technology. Course titles are shown in columns; duties and tasks, in rows. The Exit Proficiency Level Scale (see Figure 1), an ascending scale with 5 as the highest level of proficiency, includes marked boxes indicating whether the task is covered by the instructor during the course; the numbers 1–5 indicate the degree of attention given to the task and the corresponding proficiency expected on the part of the student upon completion of the course of studies. The crosswalk is intended to serve as an aide to other instructional designers and faculty in community college programs across the nation.

EXIT PROFICIENCY LEVEL SCALE					
Technical Workplace Competency	1	2	3	4	5
	Rarely	Routinely with Supervision	Routinely with Limited Supervision	Routinely Without Supervision	Initiates/ Improves/ Modifies and Supervises Others

Figure 1

Included on the following pages is the Technical Workplace Competencies and Course Crosswalk for the pilot program curriculum. This crosswalk validates the fact that the duties and tasks which were identified by industry as being necessary for entry–level employees have been incorporated into the development of the course syllabi.

Page 1

TOOL AND DIE MAKER
(includes Electrical Discharge Machine)

Technical Workplace Competencies and Course Crosswalk

	Machine Tool Technology	Intro Die Making Procedures	Die Design I	Die Design II	CNC Operations I	CNC Operations II	CNC Operations III	Die Making I	Die Making II	Die Making III	Special Project	Blueprint Reading	Principles of CAD	Introduction to Computers	Applied Math	Trigonometry	Fundamentals of EDM	Advanced EDM			EXIT PROFICIENCY LEVEL
A. PRACTICE SAFETY																					
A-1 Follow Safety Manuals and All Safety Regulations/Requirements	I	R	R		R	R	R	R	R	R	R						R	R			4
A-2 Maintain Safe Equipment and Machinery	I	R	R		R	R	R	R	R	R	R						R	R			4
A-3 Use Safe Operating Procedures for Hand and Machine Tools	I	R	R		R	R	R	R	R	R	R						R	R			4
A-4 Maintain a Clean and Safe Work Environment	I	R	R		R	R	R	R	R	R	R						R	R			4
A-5 Use Safe Material Handling Practices	I	R	R		R	R	R	R	R	R	R						R	R			4
A-6 Consult and Apply MSDS for Hazards of Various Materials	I	R	R		R	R	R	R	R	R	R						R	R			2
B. APPLY MATHEMATICAL CONCEPTS																					
B-1 Perform Basic Arithmetic Functions	R	R	R	M	M	M	R	M	M	M	M	R	R		I	R	M	M			4
B-2 Perform Basic Algebraic Operations	R	R	R	M	R	R	R	R	R	R	R	R	R		I	R	R	R			4
B-3 Use Basic Geometric Principles	R	R	R	M	R	R	R	R	R	R	R	R	R		I	R	R	R			4
B-4 Perform Basic Trigonometric Operations	R	R	R	M	R	R	R	R	R	R	R	R	R		I	R	R	R			4
B-5 Use and Apply Cartesian Coordinate System	R	R	R	M	R	M	M	R	R	R	M	R	R		I	R	R	M			4
C. INTERPRET ENGINEERING DRAWINGS AND RELATED DOCUMENTS																					
C-1 Interpret and Understand Basic Layout/Types of Drawings	R	R	R	R	R	R	R	M	M	M	M	I	R				R	R			4
C-2 Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances	R	R	R	R	R	R	R	M	M	M	M	I	R				R	R			4
C-3 Use and Apply Geometric Dimensioning and Tolerancing (GD&T)	R	R	R	R	R	R	R	R	R	R	R	I					R	R			3
C-4 Demonstrate Traditional Mechanical Drafting and Sketching Techniques											R	I									2
C-5 Understand and Use Quality Systems	I						R				R										2
D. DEMONSTRATE KNOWLEDGE OF MANUFACTURING MATERIALS																					
D-1 Identify Materials With Desired Properties	I	R	R	R				R	R	R	R						R	R			3
D-2 Identify Materials and Processes to Produce a Part	I	R	R	R				R	R	R	R						R	R			3
D-3 Discuss Classification Systems for Metal	I	R	R	R				R	R	R	R						R	R			3
E. MEASURE/INSPECT																					
E-1 Understand Metrology Terms	I	R	R		R	R	R	R	M	M	M						R	R			4
E-2 Select Measurement Tools	I	R	R		R	R	R	R	M	M	M						R	R			4

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I=Introduced and Taught R=Repeated and Reinforced M=Mastered

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TOOL AND DIE MAKER
(includes Electrical Discharge Machine)

Technical Workplace Competencies and Course Crosswalk

	Machine Tool Technology	Intro Die Making Procedures	Die Design I	Die Design II	CNC Operations I	CNC Operations II	CNC Operations III	Die Making I	Die Making II	Die Making III	Special Project	Blueprint Reading	Principles of CAD	Introduction to Computers	Applied Math	Trigonometry	Fundamentals of EDM	Advanced EDM			EXIT PROFICIENCY LEVEL
E-3 Measure With Hand Held Instruments	I	R	R		R	R	R	R	M	M	M						R	R			4
E-4 Eliminate Measurement Variables	I	R	R		R	R	R	R	M	M	M						R	R			4
E-5 Measure/Inspect Using Surface Plate and Accessories	I	R	R		R	R	R	R	M	M	M						R	R			4
E-6 Inspect Using Stationary Equipment	I	R	R		R	R	R	R	R	R	R						R	R			3
F. DEMONSTRATE KNOWLEDGE OF MANUFACTURING PROCESSES																					
F-1 Discuss Metal Cutting and Metal Cutting Tools	I	R	R	R	R	R	R	R	R	R	R						R	R			3
F-2 Operate Metal Saws	I	R	R		R	R	R	R	M	M	M										4
F-3 Operate Drill Presses and Tooling	I	R	R		R	R	R	R	M	M	M										4
F-4 Operate Engine and Turret Lathes and Tooling	I	R	R		R	R	R	R	M	M	M										4
F-5 Operate Vertical and Horizontal Mills and Tooling	I	R	R		R	R	R	R	M	M	M										4
F-6 Operate Precision Grinders	I	R	R					R	M	M	M										4
F-7 Operate Heat Treating Equipment and Processes	I	R	R					R	R	R	M										3
F-8 Operate Sheet Metal Equipment	I	R	R								R										2
F-9 Operate Welding Equipment and Processes	I	R	R								R										2
F-10 Estimate Time Required/Cost to Produce a Part	I										R										1
G. USE COMPUTERS																					
G-1 Use Computer Operating Systems						R	R				R		R	I			R	R			3
G-2 Understand Computer Terminology						R	R				R		R	I			R	R			3
G-3 Use File Management Systems						R	R				R		R	I			R	R			3
G-4 Install and Use Software Packages						R	R				R		R	I			R	R			3
H. PERFORM CAD/CAM AND CNC PROGRAMMING TASKS																					
H-1 Discuss Fundamentals of CNC Machines and Controls					I	R	M										R	M			4
H-2 Program and Operate CNC Milling Machine and Machining Center					I	R	R			R	R										3
H-3 Program and Operate CNC Lathe					I	R	R			R	R										3
H-4 Use Computer-Aided Drafting (CAD) System											R		I					R			2
H-5 Create 3-D Solid Models											R		I								1
H-6 Use Computer-Aided Manufacturing (CAM) System						I	R			R	R							R			2

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TOOL AND DIE MAKER
(includes Electrical Discharge Machine)

Technical Workplace Competencies and Course Crosswalk

	Machine Tool Technology	Intro Die Making Procedures	Die Design I	Die Design II	CNC Operations I	CNC Operations II	CNC Operations III	Die Making I	Die Making II	Die Making III	Special Project	Blueprint Reading	Principles of CAD	Introduction to Computers	Applied Math	Trigonometry	Fundamentals of EDM	Advanced EDM			EXIT PROFICIENCY LEVEL
I. PERFORM TOOL AND DIE MAKING OPERATIONS																					
I-1 Discuss Basic Types and Functions of Jigs and Fixtures		I	R	R		R	R	R	R	R	R						R	R			3
I-2 Utilize Concepts of Jig and Fixture Design		I	R	R		R	R	R	R	R	R						R	R			3
I-3 Demonstrate Understanding of Different Types of Industrial Dies		I	R	R				R	R	R	R										3
I-4 Utilize Basic Die Theory		I	R	R				R	R	M	M										4
I-5 Utilize Principles of Die Design		I	R	R				R	R	M	M										4
I-6 Perform Tool and Die Repair		I	R					R	R	M	M										4
I-7 Demonstrate Tool and Die Making Skills		I	R					R	R	M	M										4
J. OPERATE ELECTRICAL DISCHARGE MACHINE (EDM)																					
J-1 Discuss Fundamentals of EDM							I										R	R			3
J-2 Setup and Operate Conventional Sinker EDM																	I				2
J-3 Program, Setup, and Operate CNC Sinker EDM and EDM Drill																	I	R			3
J-4 Program, Setup, and Operate CNC Wire EDM							I										R	R			3

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SCANS

The Secretary's Commission on Achieving Necessary Skills (SCANS), U. S. Department of Labor, has identified in its "AMERICA 2000 REPORT" the following five competencies and a three–part foundation of skills and personal qualities that are needed for solid job performance:

COMPETENCIES:

Resources:	*Identifies, organizes, plans, and allocates resources*
Interpersonal:	*Works with others*
Information:	*Acquires and uses information*
Systems:	*Understands complex inter-relationships*
Technology:	*Works with a variety of technologies*

FOUNDATION SKILLS:

Basic Skills:	*Reads, writes, performs arithmetic and mathematical operations, listens, and speaks well*
Thinking Skills:	*Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn, and reasons*
Personal Qualities:	*Displays responsibility, self-esteem, sociability, self-management, integrity, and honesty*

Recognizing the value of SCANS proficiencies to job performance as well as the growing mandate in many states to include SCANS activities in course curricula, **MASTER** asked survey respondents to review the SCANS skill sets in the context of the draft skill standards for each occupational specialty area.**MASTER** also incorporated an evaluation of SCANS competencies and foundation skills into its assessment of the pilot training curricula. The results were summarized in a crosswalk that allowed the **MASTER** staff to modify course contents where needed to strengthen the achievement of SCANS competencies.

As soft skills, the SCANS competencies are inherently difficult to quantify. **MASTER** realizes that some faculty will emphasize the SCANS more or less than others. In time, faculty will learn to make these types of SCANS activities an integral and important part of the teaching process.

MASTER Curriculum
Tool and Die Making Technology
(Associate of Applied Science Degree Program)

		LEC	LAB	CR
First Semester*				
TLD 1016	Machine Tool Technology	3	6	6
TLD 1114	Introduction to Die Making Procedures	2	4	4
DDT 1113	Blueprint Reading and Drawing	2	2	3
CPT 1113	Introduction to Computers	2	2	3
MATH 1233	Applied Mathematics for Engineering Technicians	3	0	3
		12	14	19
Second Semester*				
TLD 1133	Die Design I	2	2	3
TLD 1146	Die Making I	3	6	6
TLD 2713	Computer Numerical Control Operations I	2	2	3
DDT 1313	Principles of CAD	2	2	3
ENGL 1113	English Composition I	3	0	3
		12	12	18
Third Semester*				
TLD 2153	Die Design II	2	2	3
TLD 2166	Die Making II	3	6	6
TLD 2723	Computer Numerical Control Operations II	2	2	3
MATH 1323	Trigonometry	3	0	3
SPT 1113	Oral Communications	3	0	3
		13	10	18
Fourth Semester*				
TLD 2174	Die Making III	2	4	4
TLD 2733	Computer Numerical Control Operations III	2	2	3
TLD 2183	Special Project	1	4	3
	Humanities/Fine Arts Elective	3	0	3
	Social or Behavioral Science Elective	3	0	3
		11	10	16
	Program Totals	48	46	71
Optional Courses:				
TLD 2113	Fundamentals of EDM	2	2	3
TLD 2123	Advanced EDM	2	2	3

TLD 1016

MASTER PROGRAM

Machine Tool Technology

COURSE SYLLABUS

Total lecture hours: 48 **Total lab hours: 96** **Credit hours: 6**

COURSE DESCRIPTION:

Is composed of fundamental skills related to machine tool operations. Topics covered in the course include safety, precision measurement, blueprint reading, hand and bench work, metallurgy, and the operation of a variety of machine tools.

PREREQUISITES: NONE

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:

1. Practice safety in the machine shop;
2. Perform accurate measurements using precision measuring tools;
3. Discuss the physics of metal cutting and metal cutting tools;
4. Set-up and operate engine lathes;
5. Set-up and operate milling machines;
6. Set-up and operate metal saws;
7. Set-up and operate drilling machines;
8. Set-up and operate precision grinders;
9. Discuss the basics of welding technology; and,
10. Discuss the basics of sheet metal processes.

REQUIRED COURSE MATERIALS:

Textbook:	*Technology of Machine Tools*, Steve Krar and Albert Check, Glencoe Publishing, Latest Edition *Student's Shop Reference Handbook*, Edward Hoffman, Industrial Press, Latest Edition
Lab Manual:	*Workbook for Machine Tools*, Krar, Oswald, St. Amand, McGraw-Hill Publishers, Latest Edition

Hand Tools/Quantity Required:

Safety Glasses	1 pair
6 inch Ruler	1/8, 1/16, 1/32, and 1/64 inch

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a hands-on machining process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Introduction to Machine Tools	
Shop Safety	
Blueprint Reading	
Precision Measurement & Inspection	
Physics of Metal Cutting	
Cutting Tool Materials	
The Engine Lathe	
Layout	
The Bandsaw	
Hand Tools and Bench Work	
The Milling Machine	
Cutting Fluids	
Drilling Machines	
The Grinding Machine	
Metallurgy	
Other Manufacturing Processes	
Total Lecture Hours	48

LAB OUTLINE:

Lab Topics	Contact Hrs.
Shop Orientation and Safety	2
Inspection and Measurement	2
Grinding a Lathe Tool	2
Use of the Engine Lathe	3
Project (Turned Shaft)	9
Thread Cutting on the Lathe	3
Layout	2
Use of the Bandsaw	2
Hand Tools and Bench Work	2
Use of the Milling Machine	3
Project (T–Bolts)	6
Use of the Drilling Machine	2
Project (Parallel Clamp)	9
Use of the Grinding Machine	2
Heat Treatment of Steel	2
Project (V–Block)	15
Project (Mini-Vise)	30
Total Lab Hours	**96**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
   A. *Resources: Identifies, organizes, plans, and allocates resources*
      1. Allocates time to complete assigned tasks on schedule
      2. Determines and allocates required materials and resources for meeting objectives
      3. Evaluates skills, performance, and quality of work and provides feedback

- *B.* *Interpersonal: Works with others*
  1. Participates as a member of the team, contributing to group effort
  2. Provides individual assistance/direction to peers as requested
  3. Determines and meets expectations
  4. Exercises leadership qualities to effectively communicate ideas and make decisions.
  5. Negotiates resources in order to accomplish objectives
  6. Works well with all members of the class
- *C.* ***Information:** Acquires and uses information*
  1. Acquires and evaluates information
  2. Organizes and maintains information
  3. Interprets and communicates information
- *D.* ***Systems:** Understands complex inter-relationships*
  1. Understands and works well with social, organizational, and technological systems
  2. Monitors and corrects performance of system during operation
  3. Recommends modifications to system to improve performance
- *E.* ***Technology:** Works with a variety of technologies*
  1. Chooses relevant procedures, tools, and equipment
  2. Applies appropriate procedures and techniques to accomplish tasks
  3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

- A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks
  - *1.* ***Reading:** Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
    - a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
    - b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
    - c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)

- d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
- e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. *Writing: Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
   - a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
   - b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
   - c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
   - d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
   - e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments
3. *Arithmetic/Mathematics: Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   - a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   - b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   - c. Demonstrates ability to understand and perform multi-step computations
   - d. Demonstrates ability to read, interpret, and use standard measuring devices
   - e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   - f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance

- g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:** Receives, attends to, interprets, and responds to oral messages and other cues*
   - a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to oral messages and instructions and to safely operate machinery
   - b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   - c. Demonstrates auditory ability to hear, comprehend, and utilize oral classroom as well as other auditory instruction
   - d. Demonstrates ability to discriminate between essential and non-essential oral information and react appropriately
   - e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
   - f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed
5. ***Speaking**: Organizes ideas and communicates orally*
   - a. Demonstrates appropriate listening and speaking skills in personal conversations
   - b. Demonstrates ability to choose and organize appropriate words to effectively communicate
   - c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
   - d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
   - e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
   - f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
   - g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:** Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   - a. Demonstrates ability to objectively assess personal strengths and weaknesses
   - b. Demonstrates ability to set realistic short-term and long-term goals

- c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
- d. Demonstrates ability to identify potential pitfalls and take evasive actions
- e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
- f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
- g. Demonstrates maturity in taking responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
    - a. Demonstrates ability to detect problem through observation, inquiry, or directive
    - b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
    - c. Demonstrates ability to generate alternatives or options for problem solution
    - d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
    - e. Demonstrates ability to initiate and effect solution
    - f. Demonstrates ability to take responsibility for outcomes
    - g. Demonstrates ability to effectively problem solve in individual, team, or group situations
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
    - a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
    - b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
    - c. Demonstrates ability to visually discriminate in gross and fine imagery
    - d. Demonstrates ability to visualize abstractly
    - e. Demonstrates ability to apply visual imagery to applied tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*

- a. Demonstrates mastery of basic reading, math, and language skills through application
- b. Demonstrates ability to translate abstract theory into practical application
- c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
- d. Demonstrates knowledge of good study skills and learning habits

5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   - a. Demonstrates use of simple logic
   - b. Demonstrates ability to distinguish relationships
   - c. Demonstrates ability to determine and isolate factors in relationships
   - d. Demonstrates and applies knowledge through practice
   - e. Recognizes that attitudes, skills, and practice are essential to productivity
   - f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   - a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   - b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
   - c. Demonstrates ability to focus on task at hand and work to completion
   - d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
   - e. Demonstrates maturity to take responsibility for actions
   - f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   - a. Presents a positive attitude toward tasks
   - b. Demonstrates ability to separate work and personal behaviors

   - c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   - d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   - e. Demonstrates ability to accept and use constructive criticism
   - f. Accepts positive reinforcement in an appropriate manner

3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   - a. Demonstrates appropriate and acceptable social behaviors in interactions
   - b. Demonstrates ability to work cooperatively in individual, team, or group situations
   - c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   - d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   - a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   - b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   - c. Demonstrates ability to formulate and follow personal schedules
   - d. Demonstrates ability to wisely use classroom time
   - e. Demonstrates use of good study habits and skills
   - f. Demonstrates maturity to take responsibility for own actions
5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   - a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   - b. Demonstrates honesty and integrity in working with peers and supervisors
   - c. Takes full responsibility for personal actions
   - d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   - e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
    TLD-A1 through TLD-A6;
    TLD-B1 through TLD-B5;
    TLD-C1 through TLD-C3;
    TLD-C5;
    TLD-D1 through TLD-D3;
    TLD-E1 through TLD-E6; and,
    TLD-F1 through TLD-F10.
2. *Machinery's Handbook,* Industrial Press, Latest Edition
3. *Machine Tool Practices,* Kibbe, Neely, and Meyer, Wiley Pub., Latest Edition
4. *Basic Blueprint Reading and Sketching,* Olivo, Olivo, and Payne, Delmar Publishers, Latest Edition

TLD 1114

MASTER PROGRAM

Introduction to Die Making Procedures

COURSE SYLLABUS

Total lecture hours: 32	Total lab hours: 64	Credit hours: 4

COURSE DESCRIPTION:

Introduces tool and die making procedures including an orientation to metallurgy and die repair. Students are instructed and given practice in the inspection, disassembly, fabrication, and reassembly of die components.

PREREQUISITES: NONE

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:
1. Understand die terminology;
2. Identify die components;
3. Explain the operation of industrial dies;
4. Practice safety in the die shop;
5. Explain basic die making procedures;
6. Properly transport and handle dies;
7. Perform disassembly and assembly of die components; and,
8. Repair or replace die components.

REQUIRED COURSE MATERIALS:

Textbook: ***Basic Diemaking***, D. Eugene Ostergaard, McGraw–Hill Publishers, Latest Edition

Lab Manual: None

Hand Tools/Quantity Required:

Safety Glasses	1 pair
6 inch Ruler	1/8, 1/16, 1/32, and 1/64 grad.

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a hands–on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Introduction to Dies	
Safety in Handling and Transport of Dies	
Die Terminology and Components	
Die Operation and Performance	
Part Inspection for Identification of Die Problems	
Disassembly and Assembly of Die Set	
Inspection of Die Set and Die Components	
Die Block Construction and Repair	
Die Block Mounting Procedures	
Construction, Sharpening, and Mounting of Punches	
Purpose and Construction of Pilots	
Purpose and Construction of Backing Plates	
Total Lecture Hours	**32**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Orientation to Die Sets	2
Safety with Die Sets and in Machine Shop	2
Operation of Die Set in Punch Press	2
Project (Disassembly and Assembly of Die Set)	4
Inspect Die Components	3
Project (Sharpen Die Components)	9
Project (Construction of Die Block)	12
Project (Punch and Pilot)	12
Project (V-Form Die Block)	18
Total Lab Hours	**64**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
   A. Resources: Identifies, organizes, plans, and allocates resources
      1. Allocates time to complete assigned tasks on schedule
      2. Determines and allocates required materials and resources for meeting objectives
      3. Evaluates skills, performance, and quality of work and provides feedback
   B. Interpersonal: Works with others
      1. Participates as a member of the team, contributing to group effort
      2. Provides individual assistance/direction to peers as requested
      3. Determines and meets expectations
      4. Exercises leadership qualities to effectively communicate ideas and make decisions.
      5. Negotiates resources in order to accomplish objectives
      6. Works well with all members of the class
   C. Information: Acquires and uses information
      1. Acquires and evaluates information
      2. Organizes and maintains information
      3. Interprets and communicates information
   D. Systems: Understands complex inter-relationships
      1. Understands and works well with social, organizational, and technological systems
      2. Monitors and corrects performance of system during operation
      3. Recommends modifications to system to improve performance
   E. Technology: Works with a variety of technologies
      1. Chooses relevant procedures, tools, and equipment

2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
    a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
    b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
    c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
    d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
    e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials
2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
    a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
    b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
    c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
    d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner

    e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
    a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
    b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
    c. Demonstrates ability to understand and perform multi-step computations
    d. Demonstrates ability to read, interpret, and use standard measuring devices
    e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
    f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
    g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines
4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
    a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to oral messages and instructions and to safely operate machinery
    b. Demonstrates ability to hear, comprehend, and appropriately follow directions
    c. Demonstrates auditory ability to hear, comprehend, and utilize oral classroom as well as other auditory instruction
    d. Demonstrates ability to discriminate between essential and non-essential oral information and react appropriately
    e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
    f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed
5. ***Speaking:*** *Organizes ideas and communicates orally*
    a. Demonstrates appropriate listening and speaking skills in personal conversations

   - b. Demonstrates ability to choose and organize appropriate words to effectively communicate
   - c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
   - d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
   - e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
   - f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
   - g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons
 1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   - a. Demonstrates ability to objectively assess personal strengths and weaknesses
   - b. Demonstrates ability to set realistic short-term and long-term goals
   - c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
   - d. Demonstrates ability to identify potential pitfalls and take evasive actions
   - e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
   - f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
   - g. Demonstrates maturity in taking responsibility for decisions
 2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   - a. Demonstrates ability to detect problem through observation, inquiry, or directive
   - b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   - c. Demonstrates ability to generate alternatives or options for problem solution

- d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
- e. Demonstrates ability to initiate and effect solution
- f. Demonstrates ability to take responsibility for outcomes
- g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:** Organizes, and processes symbols, pictures, graphs, objects, and other information*
    - a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
    - b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
    - c. Demonstrates ability to visually discriminate in gross and fine imagery
    - d. Demonstrates ability to visualize abstractly
    - e. Demonstrates ability to apply visual imagery to applied tasks
4. ***Knowing How to Learn:** Use efficient learning techniques to acquire and apply new knowledge and skills*
    - a. Demonstrates mastery of basic reading, math, and language skills through application
    - b. Demonstrates ability to translate abstract theory into practical application
    - c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
    - d. Demonstrates knowledge of good study skills and learning habits
5. ***Reasoning:** Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
    - a. Demonstrates use of simple logic
    - b. Demonstrates ability to distinguish relationships
    - c. Demonstrates ability to determine and isolate factors in relationships
    - d. Demonstrates and applies knowledge through practice
    - e. Recognizes that attitudes, skills, and practice are essential to productivity
    - f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:** Exerts a high level of effort and perseveres towards goal attainment*
    a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
    b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
    c. Demonstrates ability to focus on task at hand and work to completion
    d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
    e. Demonstrates maturity to take responsibility for actions
    f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner
2. ***Self-Esteem:** Believes in own self-worth and maintains a positive view of self*
    a. Presents a positive attitude toward tasks
    b. Demonstrates ability to separate work and personal behaviors
    c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
    d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
    e. Demonstrates ability to accept and use constructive criticism
    f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:** Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
    a. Demonstrates appropriate and acceptable social behaviors in interactions
    b. Demonstrates ability to work cooperatively in individual, team, or group situations
    c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
    d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:** Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
    a. Accepts personal strengths and weaknesses and uses the same for positive advancement

   - b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   - c. Demonstrates ability to formulate and follow personal schedules
   - d. Demonstrates ability to wisely use classroom time
   - e. Demonstrates use of good study habits and skills
   - f. Demonstrates maturity to take responsibility for own actions

5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   - a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   - b. Demonstrates honesty and integrity in working with peers and supervisors
   - c. Takes full responsibility for personal actions
   - d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   - e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
   TLD-A1 through TLD-A6;
   TLD-B1 through TLD-B5;
   TLD-C1 through TLD-C3;
   TLD-D1 through TLD-D3;
   TLD-E1 through TLD-E6;
   TLD-F1 through TLD-F9; and,
   TLD-I1 through TLD-I7.
2. *Machinery's Handbook*, Industrial Press, Latest Edition
3. *Die Design Fundamentals*, J. R. Pacquin and R. E. Crowley, Latest Edition

DDT 1113

MASTER PROGRAM

Blueprint Reading and Drawing

COURSE SYLLABUS

Total lecture hours: 32 **Total lab hours: 32** **Credit hours: 3**

COURSE DESCRIPTION:

Prepares students to read and interpret industrial drawings. Emphasis is placed on line identification, abbreviations, symbols, orthographic projection, auxiliary views, sectional views, drafting conventional practices, and sketching.

PREREQUISITES: NONE

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:

1. Interpret and understand basic layout/types of drawings;
2. Interpret and apply blueprint notes, dimensions, and tolerances;
3. Use and apply geometric dimensioning and tolerancing (GD&T) methodology; and,
4. Demonstrate traditional mechanical drafting skills.

REQUIRED COURSE MATERIALS:

Textbook: *Basic Blueprint Reading and Sketching*, Olivo, C. Thomas and Thomas P. Olivo, Delmar Publishers, Latest Edition

Lab Manual: None

Supplies:

Triangular Engineer's Scale
45' Triangle
30' X 60' Triangle
Circle Template
Compass
Mechanical Pencils

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a hands–on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all lab rules and safety regulations.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Introduction to Blueprint Reading	2
A. Parts of the Blueprint	
B. Standards Used in Blueprints	
C. Types of Drawings	
The Alphabet of Lines	2
Orthographic Projection	4
Auxiliary Views	2
Sectional Views	2
Notes and Dimensions	4
Tolerances and Limits	4
Geometric Dimensioning and Tolerancing (GD&T)	4
Technical Sketching and Drafting	8
Total Lecture Hours	**32**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Identifying Parts of a Blueprint; Line Identification	1
Multi-View Drawings; Auxiliary Views	6
Notes and Dimensions	5
Tolerances and Limits	5
Sectional Views	2
GD&T	4
Technical Sketching	3
Technical Drafting	6
Total Lab Hours	**32**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

- ***A. Resources:*** *Identifies, organizes, plans, and allocates resources*
  - **1. Allocates time to complete assigned tasks on schedule**
  - **2. Determines and allocates required materials and resources for meeting objectives**
  - **3. Evaluates skills, performance, and quality of work and provides feedback**
- ***B. Interpersonal:*** *Works with others*
  - **1. Participates as a member of the team, contributing to group effort**
  - **2. Provides individual assistance/direction to peers as requested**
  - **3. Determines and meets expectations**
  - **4. Exercises leadership qualities to effectively communicate ideas and make decisions.**
  - **5. Negotiates resources in order to accomplish objectives**
  - **6. Works well with all members of the class**
- ***C. Information:*** *Acquires and uses information*
  - **1. Acquires and evaluates information**
  - **2. Organizes and maintains information**
  - **3. Interprets and communicates information**
- ***D. Systems:*** *Understands complex inter-relationships*
  - **1. Understands and works well with social, organizational, and technological systems**
  - **2. Monitors and corrects performance of system during operation**
  - **3. Recommends modifications to system to improve performance**
- ***E. Technology:*** *Works with a variety of technologies*
  - **1. Chooses relevant procedures, tools, and equipment**
  - **2. Applies appropriate procedures and techniques to accomplish tasks**

3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks

   1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
      - a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
      - b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
      - c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
      - d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
      - e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials
   2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
      - a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
      - b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
      - c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
      - d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
      - e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:** Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
    a. **Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages**
    b. **Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems**
    c. **Demonstrates ability to understand and perform multi-step computations**
    d. **Demonstrates ability to read, interpret, and use standard measuring devices**
    e. **Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively**
    f. **Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance**
    g. **Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines**
4. ***Listening:** Receives, attends to, interprets, and responds to oral messages and other cues*
    a. **Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to oral messages and instructions and to safely operate machinery**
    b. **Demonstrates ability to hear, comprehend, and appropriately follow directions**
    c. **Demonstrates auditory ability to hear, comprehend, and utilize oral classroom as well as other auditory instruction**
    d. **Demonstrates ability to discriminate between essential and non-essential oral information and react appropriately**
    e. **Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds**
    f. **Demonstrates ability and maturity to seek and receive additional individualized instruction as needed**
5. ***Speaking:** Organizes ideas and communicates orally*
    a. **Demonstrates appropriate listening and speaking skills in personal conversations**
    b. **Demonstrates ability to choose and organize appropriate words to effectively communicate**
    c. **Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation**

d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes

e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups

f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations

g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*

a. Demonstrates ability to objectively assess personal strengths and weaknesses

b. Demonstrates ability to set realistic short-term and long-term goals

c. Demonstrates ability to recognize and distinguish between positive and negative alternatives

d. Demonstrates ability to identify potential pitfalls and take evasive actions

e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response

f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives

g. Demonstrates maturity in taking responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*

a. Demonstrates ability to detect problem through observation, inquiry, or directive

b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation

c. Demonstrates ability to generate alternatives or options for problem solution

d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution

e. Demonstrates ability to initiate and effect solution

f. Demonstrates ability to take responsibility for outcomes

        - g. Demonstrates ability to effectively problem solve in individual, team, or group situations
    - 3. ***Seeing Things In the Mind's Eye:** Organizes, and processes symbols, pictures, graphs, objects, and other information*
        - a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
        - b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
        - c. Demonstrates ability to visually discriminate in gross and fine imagery
        - d. Demonstrates ability to visualize abstractly
        - e. Demonstrates ability to apply visual imagery to applied tasks
    - 4. ***Knowing How to Learn:** Use efficient learning techniques to acquire and apply new knowledge and skills*
        - a. Demonstrates mastery of basic reading, math, and language skills through application
        - b. Demonstrates ability to translate abstract theory into practical application
        - c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
        - d. Demonstrates knowledge of good study skills and learning habits
    - 5. ***Reasoning:** Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
        - a. Demonstrates use of simple logic
        - b. Demonstrates ability to distinguish relationships
        - c. Demonstrates ability to determine and isolate factors in relationships
        - d. Demonstrates and applies knowledge through practice
        - e. Recognizes that attitudes, skills, and practice are essential to productivity
        - f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty
    - 1. ***Responsibility:** Exerts a high level of effort and perseveres towards goal attainment*
        - a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals

- b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
- c. Demonstrates ability to focus on task at hand and work to completion
- d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
- e. Demonstrates maturity to take responsibility for actions
- f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:** Believes in own self-worth and maintains a positive view of self*
    - a. Presents a positive attitude toward tasks
    - b. Demonstrates ability to separate work and personal behaviors
    - c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
    - d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
    - e. Demonstrates ability to accept and use constructive criticism
    - f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:** Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
    - a. Demonstrates appropriate and acceptable social behaviors in interactions
    - b. Demonstrates ability to work cooperatively in individual, team, or group situations
    - c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
    - d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:** Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
    - a. Accepts personal strengths and weaknesses and uses the same for positive advancement
    - b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
    - c. Demonstrates ability to formulate and follow personal schedules

  d. Demonstrates ability to wisely use classroom time
  e. Demonstrates use of good study habits and skills
  f. Demonstrates maturity to take responsibility for own actions

5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
  a. Knows and demonstrates ability to distinguish between positive and negative behaviors
  b. Demonstrates honesty and integrity in working with peers and supervisors
  c. Takes full responsibility for personal actions
  d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
  e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
    TLD-B1 through TLD-B5; and,
    TLD-C1 through TLD-C4.

MASTER PROGRAM
Introduction to Computers
COURSE SYLLABUS

Total lecture hours: 32 **Total lab hours: 32** **Credit hours: 3**

COURSE DESCRIPTION:

Introduces information processing concepts including operating systems, word processing, spreadsheets, data management, graphics, and BASIC programming.

PREREQUISITES: NONE

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:

1. Use computer operating systems;
2. Understand computer terminology;
3. Use file management systems;
4. Install and use software packages; and,
5. Perform backup on personal computer.

REQUIRED COURSE MATERIALS:

Textbook:	**None**
Lab Manual:	**Provided by Instructor**

Hand Tools/Quantity Required:
3½" Data Diskette

METHOD OF INSTRUCTION:

Lecture:	Didactic presentations will include lecture, video and demonstrations.
Laboratory:	Laboratory will be a hands–on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all lab rules and safety regulations.

LECTURE OUTLINE:

Lecture Topic	Contact Hrs.
Introduction to Computers	
Hardware and Software	
Hardware Components and Terminology	
Computer Operating Systems	
Directory Structure and File Management	
Word Processing Software	
Spreadsheet Software	
Databases	
Using Peripheral Devices	
Backup and Restore Functions	
Installation of Software	
Introduction to Use of Networking	
Total Lecture Hours	**32**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Lab Orientation and Safety	1
Demonstration of Hardware	2
Use Computer Operating Systems	2
Create Directories and Save Files	2
Create Document using Word Processor Software	4
Create Spreadsheet	4
Create Database	6
Printing (in each software program and DOS)	3
Perform Backup and Restore of Selected Files	3
Install Software	3
Log in to Network	2
Total Lab Hours	**32**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

- ***A. Resources:** Identifies, organizes, plans, and allocates resources*
  - **1. Allocates time to complete assigned tasks on schedule**
  - **2. Determines and allocates required materials and resources for meeting objectives**
  - **3. Evaluates skills, performance, and quality of work and provides feedback**
- ***B. Interpersonal:** Works with others*
  - **1. Participates as a member of the team, contributing to group effort**
  - **2. Provides individual assistance/direction to peers as requested**
  - **3. Determines and meets expectations**
  - **4. Exercises leadership qualities to effectively communicate ideas and make decisions.**
  - **5. Negotiates resources in order to accomplish objectives**
  - **6. Works well with all members of the class**
- ***C. Information:** Acquires and uses information*
  - **1. Acquires and evaluates information**
  - **2. Organizes and maintains information**
  - **3. Interprets and communicates information**
- ***D. Systems:** Understands complex inter-relationships*
  - **1. Understands and works well with social, organizational, and technological systems**
  - **2. Monitors and corrects performance of system during operation**
  - **3. Recommends modifications to system to improve performance**
- ***E. Technology:** Works with a variety of technologies*
  - **1. Chooses relevant procedures, tools, and equipment**

2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks

   1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
      a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
      b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
      c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
      d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
      e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials
   2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
      a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
      b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
      c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
      d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner

    e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
    a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
    b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
    c. Demonstrates ability to understand and perform multi-step computations
    d. Demonstrates ability to read, interpret, and use standard measuring devices
    e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
    f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
    g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines
4. ***Listening:*** *Receives, attends to, interprets, and responds to oral messages and other cues*
    a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to oral messages and instructions and to safely operate machinery
    b. Demonstrates ability to hear, comprehend, and appropriately follow directions
    c. Demonstrates auditory ability to hear, comprehend, and utilize oral classroom as well as other auditory instruction
    d. Demonstrates ability to discriminate between essential and non-essential oral information and react appropriately
    e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
    f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed
5. ***Speaking:*** *Organizes ideas and communicates orally*
    a. Demonstrates appropriate listening and speaking skills in personal conversations

   - b. Demonstrates ability to choose and organize appropriate words to effectively communicate
   - c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
   - d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
   - e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
   - f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
   - g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

- *1.* ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   - a. Demonstrates ability to objectively assess personal strengths and weaknesses
   - b. Demonstrates ability to set realistic short-term and long-term goals
   - c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
   - d. Demonstrates ability to identify potential pitfalls and take evasive actions
   - e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
   - f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
   - g. Demonstrates maturity in taking responsibility for decisions
- *2.* ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   - a. Demonstrates ability to detect problem through observation, inquiry, or directive
   - b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   - c. Demonstrates ability to generate alternatives or options for problem solution

   - d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
   - e. Demonstrates ability to initiate and effect solution
   - f. Demonstrates ability to take responsibility for outcomes
   - g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   - a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   - b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   - c. Demonstrates ability to visually discriminate in gross and fine imagery
   - d. Demonstrates ability to visualize abstractly
   - e. Demonstrates ability to apply visual imagery to applied tasks

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   - a. Demonstrates mastery of basic reading, math, and language skills through application
   - b. Demonstrates ability to translate abstract theory into practical application
   - c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   - d. Demonstrates knowledge of good study skills and learning habits

5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   - a. Demonstrates use of simple logic
   - b. Demonstrates ability to distinguish relationships
   - c. Demonstrates ability to determine and isolate factors in relationships
   - d. Demonstrates and applies knowledge through practice
   - e. Recognizes that attitudes, skills, and practice are essential to productivity
   - f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:** Exerts a high level of effort and perseveres towards goal attainment*
    - a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
    - b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
    - c. Demonstrates ability to focus on task at hand and work to completion
    - d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
    - e. Demonstrates maturity to take responsibility for actions
    - f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner
2. ***Self-Esteem:** Believes in own self-worth and maintains a positive view of self*
    - a. Presents a positive attitude toward tasks
    - b. Demonstrates ability to separate work and personal behaviors
    - c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
    - d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
    - e. Demonstrates ability to accept and use constructive criticism
    - f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:** Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
    - a. Demonstrates appropriate and acceptable social behaviors in interactions
    - b. Demonstrates ability to work cooperatively in individual, team, or group situations
    - c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
    - d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:** Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
    - a. Accepts personal strengths and weaknesses and uses the same for positive advancement

   - b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   - c. Demonstrates ability to formulate and follow personal schedules
   - d. Demonstrates ability to wisely use classroom time
   - e. Demonstrates use of good study habits and skills
   - f. Demonstrates maturity to take responsibility for own actions

5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   - a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   - b. Demonstrates honesty and integrity in working with peers and supervisors
   - c. Takes full responsibility for personal actions
   - d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   - e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
   TLD-G1 through TLD-G4

CPT 1113
03/061697

MATH 1233

MASTER PROGRAM

Applied Mathematics for Engineering Technicians

COURSE SYLLABUS

Total lecture hours: 48 **Total lab hours: 0** **Credit hours: 3**

COURSE DESCRIPTION:

Equips the student with the mathematical skills and knowledge required for complex calculations in the machine tool trades. Emphasis is on the application of common mathematical concepts in a typical shop environment. Topics covered are basic arithmetic functions. Algebraic operations, geometric principles, trigonometric operations, and the Cartesian coordinate system.

PREREQUISITE: None

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:

1. Perform basic arithmetic functions;
2. Perform basic algebraic operations;
3. Use basic geometric principles;
4. Perform basic trigonometric operations; and,
5. Use and apply the Cartesian coordinate system.

REQUIRED COURSE MATERIALS:

Textbook: *Mathematics for Machine Technology*, Smith, Robert D., Delmar Publishers, Latest Edition

Supplies: Scientific Calculator

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete assignments;
2. Apply theory to assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments, including writing assignments, and oral presentations;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all rules and safety regulations.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Section A	8
Operations on Whole Numbers	
Operations on Fractions	
Operations on Decimal Fractions	
Metric/English Conversions	
Section B	15
Evaluating Algebraic Expressions	
Signed Numbers	
Equations with One Unknown Variable	
Ratio and Proportion Problems	
Section C	8
Angular Geometric Principles	
Perimeter of Geometric Figures	
Area of Geometric Figures	
Volume of Geometric Figures	
Lateral Surface Area of Geometric Figures	
Section D	12
The Pythagorean Theorem	
Trigonometric Functions	
Isosceles Triangles	
Section E	5
The Cartesian Coordinate System	
Plotting Points	
Calculating Bolt Hole Circles	—
Total Lecture Hours	48

COURSE OBJECTIVES: SCANS COMPETENCIES

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    1. **Chooses relevant procedures, tools, and equipment**
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B. **Thinking Skills:** **Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons**

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
a. **Demonstrates ability to objectively assess personal strengths and weaknesses**
b. **Demonstrates ability to set realistic short-term and long-term goals**
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c. **Demonstrates ability to generate alternatives or options for problem solution**
d. **Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution**

- e. Demonstrates ability to initiate and effect solution
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3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
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   - b. Demonstrates ability to translate abstract theory into practical application
   - c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   - d. Demonstrates knowledge of good study skills and learning habits
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   - c. Demonstrates ability to determine and isolate factors in relationships
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1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*

   - a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
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   - c. Demonstrates ability to focus on task at hand and work to completion
   - d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
   - e. Demonstrates maturity to take responsibility for actions
   - f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:** Believes in own self-worth and maintains a positive view of self*
   - a. Presents a positive attitude toward tasks
   - b. Demonstrates ability to separate work and personal behaviors
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   - d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
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   - c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   - d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
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   - a. Accepts personal strengths and weaknesses and uses the same for positive advancement

- b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
- c. Demonstrates ability to formulate and follow personal schedules
- d. Demonstrates ability to wisely use classroom time
- e. Demonstrates use of good study habits and skills
- f. Demonstrates maturity to take responsibility for own actions

5. *Integrity/Honesty: Chooses ethical courses of action*
    - a. Knows and demonstrates ability to distinguish between positive and negative behaviors
    - b. Demonstrates honesty and integrity in working with peers and supervisors
    - c. Takes full responsibility for personal actions
    - d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
    - e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
    TLD-B1 through TLD-B5.

MASTER Curriculum
Tool and Die Making Technology
(Associate of Applied Science Degree Program)

		LEC	LAB	CR
First Semester*				
TLD 1016	Machine Tool Technology	3	6	6
TLD 1114	Introduction to Die Making Procedures	2	4	4
DDT 1113	Blueprint Reading and Drawing	2	2	3
CPT 1113	Introduction to Computers	2	2	3
MATH 1233	Applied Mathematics for Engineering Technicians	3	0	3
		12	14	19
Second Semester*				
TLD 1133	Die Design I	2	2	3
TLD 1146	Die Making I	3	6	6
TLD 2713	Computer Numerical Control Operations I	2	2	3
DDT 1313	Principles of CAD	2	2	3
ENGL 1113	English Composition I	3	0	3
		12	12	18
Third Semester*				
TLD 2153	Die Design II	2	2	3
TLD 2166	Die Making II	3	6	6
TLD 2723	Computer Numerical Control Operations II	2	2	3
MATH 1323	Trigonometry	3	0	3
SPT 1113	Oral Communications	3	0	3
		13	10	18
Fourth Semester*				
TLD 2174	Die Making III	2	4	4
TLD 2733	Computer Numerical Control Operations III	2	2	3
TLD 2183	Special Project	1	4	3
	Humanities/Fine Arts Elective	3	0	3
	Social or Behavioral Science Elective	3	0	3
		11	10	16
	Program Totals	48	46	71
Optional Courses:				
TLD 2113	Fundamentals of EDM	2	2	3
TLD 2123	Advanced EDM	2	2	3

TLD 1133

MASTER PROGRAM

Die Design I

COURSE SYLLABUS

Total lecture hours: 32 **Total lab hours: 32** **Credit hours: 3**

COURSE DESCRIPTION:

Covers the fundamentals of design of industrial dies and the machining characteristics of die components. This course serves as a continuation of Introduction to Die Making Procedures and Machine Tool Technology. The student is introduced to additional machining skills that will be encountered in typical die shops in the building of dies, jigs, fixtures, and precision machine parts.

PREREQUISITES: **Machine Tool Technology;**
Introduction to Die Making Procedures

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:

1. Practice safety in the die shop;
2. Make advanced set–ups using milling machine accessories (indexing head, rotary head, etc.);
3. Make advanced set–ups using lathe accessories (taper attachment, four–jaw chuck, etc.);
4. Make advanced set–ups using grinding machine accessories (sine bar or chuck, form wheels, etc.); and,
5. Set–up and operate tool and cutter grinder.

REQUIRED COURSE MATERIALS:

Textbook: (1) *Technology of Machine Tools*, Steve Krar and Albert Check, Glencoe Publishing, Latest Edition
(2) *Basic Diemaking*, D. Eugene Ostergaard, McGraw–Hill Publishers, Latest Edition

Hand Tools/Quantity Required:

Safety Glasses	1 pair
6 inch Ruler	1/8, 1/16, 1/32, and 1/64 grad.

METHOD OF INSTRUCTION:

Lecture:	Didactic presentations will include lecture, video and demonstrations.
Laboratory:	Laboratory will be a hands–on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual;

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Introduction to Die and Fixture Design	
Safety in a Die Shop	
Stamping Designs	
Die Engineering — Planning and Design	
Special Characteristics of Die Components	
Special Milling Operations	
Tool and Cutter Grinder	
Indexing or Dividing Head	
Special Grinding Operations	
Special Turning Operations	
Punch and Die Shoe Construction	
Sine Bar and Vises	
Construction of V–Dies	
Hardness Testing of Metal	
Total Lecture Hours	32

LAB OUTLINE:

Lab Topics	Contact Hrs.
Introduction to the Design of Dies	1
Safety in the Die Shop	1
Visual Survey of Stampings	1
Project (Mill T–Slot and Dovetail in Block)	3
Project (Grind Radius Tool)	3
Project (Mill Convex and Concave Radius in Block)	3
Project (Grind Radius Tool)	6
Project (Dress Grinding Wheel)	2
Project (Grind Radius on Block)	2
Project (Tapered Punch)	4
Project (V–Die Block)	6
Total Lab Hours	32

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
  A. *Resources: Identifies, organizes, plans, and allocates resources*
    1. Allocates time to complete assigned tasks on schedule
    2. Determines and allocates required materials and resources for meeting objectives
    3. Evaluates skills, performance, and quality of work and provides feedback
  B. *Interpersonal: Works with others*
    1. Participates as a member of the team, contributing to group effort
    2. Provides individual assistance/direction to peers as requested
    3. Determines and meets expectations

        4. Exercises leadership qualities to effectively communicate ideas and make decisions.
        5. Negotiates resources in order to accomplish objectives
        6. Works well with all members of the class
    C. ***Information:*** *Acquires and uses information*
        1. Acquires and evaluates information
        2. Organizes and maintains information
        3. Interprets and communicates information
    D. ***Systems:*** *Understands complex inter-relationships*
        1. Understands and works well with social, organizational, and technological systems
        2. Monitors and corrects performance of system during operation
        3. Recommends modifications to system to improve performance
    E. ***Technology:*** *Works with a variety of technologies*
        1. Chooses relevant procedures, tools, and equipment
        2. Applies appropriate procedures and techniques to accomplish tasks
        3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS
    A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks
        1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
            a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
            b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
            c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
            d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
            e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
    a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
    b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
    c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
    d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
    e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments
3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
    a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
    b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
    c. Demonstrates ability to understand and perform multi-step computations
    d. Demonstrates ability to read, interpret, and use standard measuring devices
    e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
    f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
    g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines
4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
    a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to oral messages and instructions and to safely operate machinery

- b. Demonstrates ability to hear, comprehend, and appropriately follow directions
- c. Demonstrates auditory ability to hear, comprehend, and utilize oral classroom as well as other auditory instruction
- d. Demonstrates ability to discriminate between essential and non-essential oral information and react appropriately
- e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
- f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. ***Speaking**: Organizes ideas and communicates orally*

- a. Demonstrates appropriate listening and speaking skills in personal conversations
- b. Demonstrates ability to choose and organize appropriate words to effectively communicate
- c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
- d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
- e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
- f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
- g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:** Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*

- a. Demonstrates ability to objectively assess personal strengths and weaknesses
- b. Demonstrates ability to set realistic short-term and long-term goals
- c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
- d. Demonstrates ability to identify potential pitfalls and take evasive actions
- e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response

    f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
    g. Demonstrates maturity in taking responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
    a. Demonstrates ability to detect problem through observation, inquiry, or directive
    b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
    c. Demonstrates ability to generate alternatives or options for problem solution
    d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
    e. Demonstrates ability to initiate and effect solution
    f. Demonstrates ability to take responsibility for outcomes
    g. Demonstrates ability to effectively problem solve in individual, team, or group situations
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
    a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
    b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
    c. Demonstrates ability to visually discriminate in gross and fine imagery
    d. Demonstrates ability to visualize abstractly
    e. Demonstrates ability to apply visual imagery to applied tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
    a. Demonstrates mastery of basic reading, math, and language skills through application
    b. Demonstrates ability to translate abstract theory into practical application
    c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
    d. Demonstrates knowledge of good study skills and learning habits

5. ***Reasoning:** Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
    - a. Demonstrates use of simple logic
    - b. Demonstrates ability to distinguish relationships
    - c. Demonstrates ability to determine and isolate factors in relationships
    - d. Demonstrates and applies knowledge through practice
    - e. Recognizes that attitudes, skills, and practice are essential to productivity
    - f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:** Exerts a high level of effort and perseveres towards goal attainment*
    - a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
    - b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
    - c. Demonstrates ability to focus on task at hand and work to completion
    - d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
    - e. Demonstrates maturity to take responsibility for actions
    - f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner
2. ***Self-Esteem:** Believes in own self-worth and maintains a positive view of self*
    - a. Presents a positive attitude toward tasks
    - b. Demonstrates ability to separate work and personal behaviors
    - c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
    - d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
    - e. Demonstrates ability to accept and use constructive criticism
    - f. Accepts positive reinforcement in an appropriate manner

3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
    a. Demonstrates appropriate and acceptable social behaviors in interactions
    b. Demonstrates ability to work cooperatively in individual, team, or group situations
    c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
    d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
    a. Accepts personal strengths and weaknesses and uses the same for positive advancement
    b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
    c. Demonstrates ability to formulate and follow personal schedules
    d. Demonstrates ability to wisely use classroom time
    e. Demonstrates use of good study habits and skills
    f. Demonstrates maturity to take responsibility for own actions
5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
    a. Knows and demonstrates ability to distinguish between positive and negative behaviors
    b. Demonstrates honesty and integrity in working with peers and supervisors
    c. Takes full responsibility for personal actions
    d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
    e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
    TLD-A1 through TLD-A6;
    TLD-B1 through TLD-B5;
    TLD-C1 through TLD-C3;
    TLD-D1 through TLD-D3;

TLD-E1 through TLD-E6;
TLD-F1 through TLD-F9; and,
TLD-I1 through TLD-I7.

2. *Machinery's Handbook,* Industrial Press, Latest Edition
3. *Die Design Fundamentals,* J. R. Pacquin and R. E. Crowley, Latest Edition
4. *Student's Shop Reference Handbook,* Edward G. Hoffman, Latest Edition

TLD 1133
[illegible]

TLD 1146

MASTER PROGRAM

Die Making I

COURSE SYLLABUS

Total lecture hours: 48	Total lab hours: 96	Credit hours: 6

COURSE DESCRIPTION:

Continues Introduction to Die Making Procedures with instruction and practice in building a complete functional die from a blueprint. Emphasis is placed on analyzing requirements, managing the project toward completion, and becoming proficient in shop practices and procedures.

PREREQUISITES: **Introduction to Die Making Procedures**

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:

1. Practice safety in the die shop;
2. Interpret die blueprint;
3. Purchase stock material and buy components;
4. Manufacture and assemble component parts; and,
5. Mount die and perform try–out in press machine.

REQUIRED COURSE MATERIALS:

Textbook: *Basic Diemaking,* D. Eugene Ostergaard, McGraw–Hill Publishers, Latest Edition

Lab Manual: None

Hand Tools/Quantity Required:

Safety Glasses	1 pair
6 inch Ruler	1/8, 1/16, 1/32, and 1/64 grad.

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a hands–on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Introduction to Die Building	
Safety in the Die Shop	
The Die Blueprint	
Component Requirements	
Material Requirements and Specifications	
Planning Machining Events	
Importance of Inspection and Accuracy	
The Die Shoes, Guide Posts and Bushings	
Die Block Construction	
Calculations for V–Form Dies	
Heat Treatment of Die Components	
Mounting Procedures	
Overview of the Punch Press	
Total Lecture Hours	48

LAB OUTLINE:

Lab Topics	Contact Hrs.
Orientation and Safety	2
Material Inventory	2
Material Requisitioning for V–Form Die	2
Project (V–Form Die)	84
Tryout of V–Form Die	6
Total Lab Hours	96

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
  A. ***Resources:*** *Identifies, organizes, plans, and allocates resources*
    1. Allocates time to complete assigned tasks on schedule
    2. Determines and allocates required materials and resources for meeting objectives
    3. Evaluates skills, performance, and quality of work and provides feedback
  B. ***Interpersonal:*** *Works with others*
    1. Participates as a member of the team, contributing to group effort
    2. Provides individual assistance/direction to peers as requested
    3. Determines and meets expectations
    4. Exercises leadership qualities to effectively communicate ideas and make decisions.
    5. Negotiates resources in order to accomplish objectives
    6. Works well with all members of the class
  C. ***Information:*** *Acquires and uses information*
    1. Acquires and evaluates information
    2. Organizes and maintains information
    3. Interprets and communicates information
  D. ***Systems:*** *Understands complex inter-relationships*
    1. Understands and works well with social, organizational, and technological systems
    2. Monitors and corrects performance of system during operation
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    1. Chooses relevant procedures, tools, and equipment
    2. Applies appropriate procedures and techniques to accomplish tasks

3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks

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3. ***Arithmetic/Mathematics:** Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
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    - c. **Demonstrates ability to understand and perform multi-step computations**
    - d. **Demonstrates ability to read, interpret, and use standard measuring devices**
    - e. **Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively**
    - f. **Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance**
    - g. **Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines**
4. ***Listening:** Receives, attends to, interprets, and responds to verbal messages and other cues*
    - a. **Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to oral messages and instructions and to safely operate machinery**
    - b. **Demonstrates ability to hear, comprehend, and appropriately follow directions**
    - c. **Demonstrates auditory ability to hear, comprehend, and utilize oral classroom as well as other auditory instruction**
    - d. **Demonstrates ability to discriminate between essential and non-essential oral information and react appropriately**
    - e. **Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds**
    - f. **Demonstrates ability and maturity to seek and receive additional individualized instruction as needed**
5. ***Speaking:** Organizes ideas and communicates orally*
    - a. **Demonstrates appropriate listening and speaking skills in personal conversations**
    - b. **Demonstrates ability to choose and organize appropriate words to effectively communicate**
    - c. **Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation**

- d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
- e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
- f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
- g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
    - a. Demonstrates ability to objectively assess personal strengths and weaknesses
    - b. Demonstrates ability to set realistic short-term and long-term goals
    - c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
    - d. Demonstrates ability to identify potential pitfalls and take evasive actions
    - e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
    - f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
    - g. Demonstrates maturity in taking responsibility for decisions
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
    - a. Demonstrates ability to detect problem through observation, inquiry, or directive
    - b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
    - c. Demonstrates ability to generate alternatives or options for problem solution
    - d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
    - e. Demonstrates ability to initiate and effect solution
    - f. Demonstrates ability to take responsibility for outcomes

        g. Demonstrates ability to effectively problem solve in individual, team, or group situations
    3. ***Seeing Things In the Mind's Eye:** Organizes, and processes symbols, pictures, graphs, objects, and other information*
        a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
        b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
        c. Demonstrates ability to visually discriminate in gross and fine imagery
        d. Demonstrates ability to visualize abstractly
        e. Demonstrates ability to apply visual imagery to applied tasks
    4. ***Knowing How to Learn:** Use efficient learning techniques to acquire and apply new knowledge and skills*
        a. Demonstrates mastery of basic reading, math, and language skills through application
        b. Demonstrates ability to translate abstract theory into practical application
        c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
        d. Demonstrates knowledge of good study skills and learning habits
    5. ***Reasoning:** Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
        a. Demonstrates use of simple logic
        b. Demonstrates ability to distinguish relationships
        c. Demonstrates ability to determine and isolate factors in relationships
        d. Demonstrates and applies knowledge through practice
        e. Recognizes that attitudes, skills, and practice are essential to productivity
        f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty
    1. ***Responsibility:** Exerts a high level of effort and perseveres towards goal attainment*
        a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals

- b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
- c. Demonstrates ability to focus on task at hand and work to completion
- d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
- e. Demonstrates maturity to take responsibility for actions
- f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
    - a. Presents a positive attitude toward tasks
    - b. Demonstrates ability to separate work and personal behaviors
    - c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
    - d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
    - e. Demonstrates ability to accept and use constructive criticism
    - f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
    - a. Demonstrates appropriate and acceptable social behaviors in interactions
    - b. Demonstrates ability to work cooperatively in individual, team, or group situations
    - c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
    - d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
    - a. Accepts personal strengths and weaknesses and uses the same for positive advancement
    - b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
    - c. Demonstrates ability to formulate and follow personal schedules

   - d. Demonstrates ability to wisely use classroom time
   - e. Demonstrates use of good study habits and skills
   - f. Demonstrates maturity to take responsibility for own actions

5. *Integrity/Honesty: Chooses ethical courses of action*
   - a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   - b. Demonstrates honesty and integrity in working with peers and supervisors
   - c. Takes full responsibility for personal actions
   - d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   - e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
   TLD-A1 through TLD-A6;
   TLD-B1 through TLD-B5;
   TLD-C1 through TLD-C3;
   TLD-D1 through TLD-D3;
   TLD-E1 through TLD-E6;
   TLD-F1 through TLD-F7; and,
   TLD-I1 through TLD-I7.
2. *Machinery's Handbook,* Industrial Press, Latest Edition
3. *Die Design Fundamentals,* J. R. Pacquin and R.E. Crowley, Latest Edition

TLD 1146
03/022098

TLD 2713

MASTER PROGRAM

Computer Numerical Control Operations I

COURSE SYLLABUS

Total lecture hours: 32	**Total lab hours: 32**	**Credit hours: 3**

COURSE DESCRIPTION:

Introduces computer numerical control machines. Includes instruction and practice related to the use of the Cartesian coordinate system, programming codes and styles, and operation of basic CNC machines.

PREREQUISITES: Machine Tool Technology

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:

1. Explain principles of CNC;
2. Practice safety with CNC equipment;
3. Plan sequence of machining events;
4. Set–up, program, and operate CNC training lathe; and,
5. Set–up, program, and operate CNC training mill.

REQUIRED COURSE MATERIALS:

Textbook:	*An Introduction to CNC Machining and Programming,* David Gibbs and Thomas M. Crandell, Industrial Press, Latest Edition
Lab Manual:	Instructor Provided Materials

Hand Tools/Quantity Required:

Safety Glasses	1 pair
6 inch Ruler	1/8, 1/16, 1/32, and 1/64 inch

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a hands–on machining process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

Lecture Topics	**Contact Hrs.**
Orientation to CNC Machines	
Safety with CNC Equipment	
CNC versus Conventional Machining	
Cartesian Coordinate System	
Introduction to CNC Lathe (Training Lathe)	
Planning Turning Operations	
Basic Program Structure	
Manual Data Input	
Tool Positioning and Offsets	
Introduction to CNC Mill (Training Mill)	
Planning CNC Milling Operations	
Basic Program Structure	
Tool Positioning, Offsets, and Registers	
Magnetic and Paper Tape Operation	
Introduction to Direct Numerical Control (DNC)	
Total Lecture Hours	**32**

LAB OUTLINE:

Lab Topics	**Contact Hrs.**
Introduction to CNC Machines and Safety	2
Demonstration of CNC Equipment	2
Operation of CNC Training Lathe	2
Project (Turn and Journal Shaft)	3
Project (Turn Part with Radii, Angles, and Grooves)	3
Project (Threaded Shaft)	3

Operation of CNC Training Mill	2
Project (Drilled Plate)	3
Project (Milled Plate)	3
Entering Data via Magnetic or Paper Tape	1
Project (Plexiglass Nameplate)	3
Entering Data via DNC	1
Project (Milled Plate with Pocket and Name)	4
Total Lab Hours	**32**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
   A. ***Resources:*** *Identifies, organizes, plans, and allocates resources*
      1. Allocates time to complete assigned tasks on schedule
      2. Determines and allocates required materials and resources for meeting objectives
      3. Evaluates skills, performance, and quality of work and provides feedback
   B. ***Interpersonal:*** *Works with others*
      1. Participates as a member of the team, contributing to group effort
      2. Provides individual assistance/direction to peers as requested
      3. Determines and meets expectations
      4. Exercises leadership qualities to effectively communicate ideas and make decisions.
      5. Negotiates resources in order to accomplish objectives
      6. Works well with all members of the class
   C. ***Information:*** *Acquires and uses information*
      1. Acquires and evaluates information
      2. Organizes and maintains information

        3. Interprets and communicates information

    D. Systems: Understands complex inter-relationships

        1. Understands and works well with social, organizational, and technological systems
        2. Monitors and corrects performance of system during operation
        3. Recommends modifications to system to improve performance

    E. Technology: Works with a variety of technologies

        1. Chooses relevant procedures, tools, and equipment
        2. Applies appropriate procedures and techniques to accomplish tasks
        3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks

*1. **Reading:** Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*

- a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
- b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
- c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
- d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
- e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

*2. **Writing:** Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*

- a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning

b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. Demonstrates ability to understand and perform multi-step computations
   d. Demonstrates ability to read, interpret, and use standard measuring devices
   e. Demonstrates ability to comprehènd, retain, and utilize course specific measuring devices effectively
   f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to oral messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to oral messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   c. Demonstrates auditory ability to hear, comprehend, and utilize oral classroom as well as other auditory instruction
   d. Demonstrates ability to discriminate between essential and non-essential oral information and react appropriately

e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. ***Speaking**: Organizes ideas and communicates orally*
a. Demonstrates appropriate listening and speaking skills in personal conversations
b. Demonstrates ability to choose and organize appropriate words to effectively communicate
c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:** Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
a. Demonstrates ability to objectively assess personal strengths and weaknesses
b. Demonstrates ability to set realistic short-term and long-term goals
c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
d. Demonstrates ability to identify potential pitfalls and take evasive actions
e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
g. Demonstrates maturity in taking responsibility for decisions

2. ***Problem Solving:** Recognizes problems and devises and implements plan of action*

- a. Demonstrates ability to detect problem through observation, inquiry, or directive
- b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
- c. Demonstrates ability to generate alternatives or options for problem solution
- d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
- e. Demonstrates ability to initiate and effect solution
- f. Demonstrates ability to take responsibility for outcomes
- g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*

- a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
- b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
- c. Demonstrates ability to visually discriminate in gross and fine imagery
- d. Demonstrates ability to visualize abstractly
- e. Demonstrates ability to apply visual imagery to applied tasks

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*

- a. Demonstrates mastery of basic reading, math, and language skills through application
- b. Demonstrates ability to translate abstract theory into practical application
- c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
- d. Demonstrates knowledge of good study skills and learning habits

5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*

- a. Demonstrates use of simple logic
- b. Demonstrates ability to distinguish relationships
- c. Demonstrates ability to determine and isolate factors in relationships

        - d. Demonstrates and applies knowledge through practice
        - e. Recognizes that attitudes, skills, and practice are essential to productivity
        - f. Demonstrates ability to discriminate between positive and negative, and act accordingly

- C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty
    - *1.* ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
        - a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
        - b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
        - c. Demonstrates ability to focus on task at hand and work to completion
        - d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
        - e. Demonstrates maturity to take responsibility for actions
        - f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner
    - *2.* ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
        - a. Presents a positive attitude toward tasks
        - b. Demonstrates ability to separate work and personal behaviors
        - c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
        - d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
        - e. Demonstrates ability to accept and use constructive criticism
        - f. Accepts positive reinforcement in an appropriate manner
    - *3.* ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
        - a. Demonstrates appropriate and acceptable social behaviors in interactions
        - b. Demonstrates ability to work cooperatively in individual, team, or group situations

   - c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   - d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly

4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   - a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   - b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   - c. Demonstrates ability to formulate and follow personal schedules
   - d. Demonstrates ability to wisely use classroom time
   - e. Demonstrates use of good study habits and skills
   - f. Demonstrates maturity to take responsibility for own actions
5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   - a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   - b. Demonstrates honesty and integrity in working with peers and supervisors
   - c. Takes full responsibility for personal actions
   - d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   - e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
   - TLD-A1 through TLD-A6;
   - TLD-B1 through TLD-B5;
   - TLD-C1 through TLD-C3;
   - TLD-E1 through TLD-E6;
   - TLD-F1 through TLD-F5; and
   - TLD-H1 through TLD-H3.
2. *Machinist Handbook*, Latest Edition
3. *Machinery's Handbook*, Industrial Press, Latest Edition
4. *Machine Tool Practices*, Kibbe, Neely, and Meyer, Wiley Publishers, Latest Edition

5. *Technology of Machine Tools*, Steve Krar and Albert Check, Glencoe Publishing, Latest Edition
6. *Student's Shop Reference Handbook*, Edward Hoffman, Industrial Press, Latest Edition

TLD 2713
03/061697

DDT 1313

MASTER PROGRAM

Principles of CAD

COURSE SYLLABUS

Total lecture hours: 32 **Total lab hours: 32** **Credit hours: 3**

COURSE DESCRIPTION:

Uses CAD machines to design and draw various problems in the architectural, mechanical, and civil drafting areas. Emphasis is placed on the operations of the CAD system to solve these problems.

PREREQUISITES: NONE

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:

1. Explain the components and requirements of a CAD system;
2. Create geometry using CAD system;
3. Dimension geometry in CAD system;
4. Practice file management;
5. Use peripheral devices (plotters, printers); and,
6. Export geometry to accepted data exchange formats.

REQUIRED COURSE MATERIALS:

Textbook:	**None**
Lab Manual:	**Supplied by Instructor**

Hand Tools/Quantity Required:

3½" Floppy Disk	1
3–Ring Binder	1

METHOD OF INSTRUCTION:

Lecture:	Didactic presentations will include lecture, video and demonstrations.
Laboratory:	Laboratory will be a hands–on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all lab rules and safety regulations.

LECTURE OUTLINE:

Lecture Topic	Contact Hrs.
Computers in Drafting and Design	
CAD Hardware and Software	
CAD Commands — Getting Started	
Lines, Circles and Arcs	
Trimming and Editing	
Special Geometric Shapes	
Moving, Copying, and Rotating	
Viewpoint and Layer Control	
Configuration Settings	
Dimensioning	
Sectioning	
Peripheral Devices	
Total Lecture Hours	32

LAB OUTLINE:

Lab Topics	Contact Hrs.
Introduction to CAD System and Safety	1
Getting Started with CAD System	2
Creation of Lines, Arc, and Circles	2
Editing Geometry	2
Moving, Copying, and Rotating	2
Viewpoint and Layer Control	2
Project (Drawing–No Dimensions)	3
Project (Drawing–No Dimensions)	3
Dimensioning	2
Project	3
Sectioning	2
Project	3

Peripheral Devices		2
Project		3
	Total Lab Hours	**32**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
  A. *Resources: Identifies, organizes, plans, and allocates resources*
    1. Allocates time to complete assigned tasks on schedule
    2. Determines and allocates required materials and resources for meeting objectives
    3. Evaluates skills, performance, and quality of work and provides feedback
  B. *Interpersonal: Works with others*
    1. Participates as a member of the team, contributing to group effort
    2. Provides individual assistance/direction to peers as requested
    3. Determines and meets expectations
    4. Exercises leadership qualities to effectively communicate ideas and make decisions.
    5. Negotiates resources in order to accomplish objectives
    6. Works well with all members of the class
  C. *Information: Acquires and uses information*
    1. Acquires and evaluates information
    2. Organizes and maintains information
    3. Interprets and communicates information
  D. *Systems: Understands complex inter-relationships*

1. Understands and works well with social, organizational, and technological systems
2. Monitors and corrects performance of system during operation
3. Recommends modifications to system to improve performance

E. ***Technology:*** *Works with a variety of technologies*

1. Chooses relevant procedures, tools, and equipment
2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*

- a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
- b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
- c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
- d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
- e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*

- a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
- b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.

    c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
    d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
    e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
    a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
    b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
    c. Demonstrates ability to understand and perform multi-step computations
    d. Demonstrates ability to read, interpret, and use standard measuring devices
    e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
    f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
    g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
    a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to oral messages and instructions and to safely operate machinery
    b. Demonstrates ability to hear, comprehend, and appropriately follow directions
    c. Demonstrates auditory ability to hear, comprehend, and utilize oral classroom as well as other auditory instruction
    d. Demonstrates ability to discriminate between essential and non-essential oral information and react appropriately
    e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds

        - f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed
    - 5. ***Speaking**: Organizes ideas and communicates orally*
        - a. Demonstrates appropriate listening and speaking skills in personal conversations
        - b. Demonstrates ability to choose and organize appropriate words to effectively communicate
        - c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
        - d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
        - e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
        - f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
        - g. Demonstrates ability to take responsibility for presentations

- B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons
    - *1.* ***Decision Making:** Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
        - a. Demonstrates ability to objectively assess personal strengths and weaknesses
        - b. Demonstrates ability to set realistic short-term and long-term goals
        - c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
        - d. Demonstrates ability to identify potential pitfalls and take evasive actions
        - e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
        - f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
        - g. Demonstrates maturity in taking responsibility for decisions
    - *2.* ***Problem Solving:** Recognizes problems and devises and implements plan of action*
        - a. Demonstrates ability to detect problem through observation, inquiry, or directive

    b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
    c. Demonstrates ability to generate alternatives or options for problem solution
    d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
    e. Demonstrates ability to initiate and effect solution
    f. Demonstrates ability to take responsibility for outcomes
    g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
    a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
    b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
    c. Demonstrates ability to visually discriminate in gross and fine imagery
    d. Demonstrates ability to visualize abstractly
    e. Demonstrates ability to apply visual imagery to applied tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
    a. Demonstrates mastery of basic reading, math, and language skills through application
    b. Demonstrates ability to translate abstract theory into practical application
    c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
    d. Demonstrates knowledge of good study skills and learning habits
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
    a. Demonstrates use of simple logic
    b. Demonstrates ability to distinguish relationships
    c. Demonstrates ability to determine and isolate factors in relationships
    d. Demonstrates and applies knowledge through practice

e. Recognizes that attitudes, skills, and practice are essential to productivity

f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*

a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals

b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner

c. Demonstrates ability to focus on task at hand and work to completion

d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time

e. Demonstrates maturity to take responsibility for actions

f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. *Self-Esteem: Believes in own self-worth and maintains a positive view of self*

a. Presents a positive attitude toward tasks

b. Demonstrates ability to separate work and personal behaviors

c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors

d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors

e. Demonstrates ability to accept and use constructive criticism

f. Accepts positive reinforcement in an appropriate manner

3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*

a. Demonstrates appropriate and acceptable social behaviors in interactions

b. Demonstrates ability to work cooperatively in individual, team, or group situations

c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner

   - d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:** Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   - a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   - b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   - c. Demonstrates ability to formulate and follow personal schedules
   - d. Demonstrates ability to wisely use classroom time
   - e. Demonstrates use of good study habits and skills
   - f. Demonstrates maturity to take responsibility for own actions
5. ***Integrity/Honesty:** Chooses ethical courses of action*
   - a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   - b. Demonstrates honesty and integrity in working with peers and supervisors
   - c. Takes full responsibility for personal actions
   - d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   - e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
   TLD-B1 through TLD-B5;
   TLD-C1 through TLD-C2;
   TLD-G1 through TLD-G4; and,
   TLD-H4 through TLD-H5.

DDT 1313
03/081697

ENGL 1113

MASTER PROGRAM

English Composition I

COURSE SYLLABUS

Total lecture hours: 48 **Total lab hours: 0** **Credit hours: 3**

COURSE DESCRIPTION:

Is a study of grammar and composition, with emphasis on the sentence and the paragraph. The course includes reading and writing frequent themes.

PREREQUISITE: None

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:

1. Select a clearly defined subject and address it to a specific audience in a logical manner;
2. Develop a unified and coherent theme that uses standard American grammar;
3. Use a handbook and a dictionary as resources for writing;
4. Compose written assignments using various strategies of informative and persuasive prose;
5. Compose well organized answers to questions posed on written examinations; and,
6. Critically analyze assigned essays.

REQUIRED COURSE MATERIALS:

Textbook: *The Student Writer,* Barbara Clouse, McGraw–Hill, Inc., New York, Latest Edition

Supplies:
College Level Dictionary
Theme folder
Theme paper

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete assignments;
2. Apply theory to assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments, including writing assignments, and oral presentations;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all rules and safety regulations.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Introduction to Course	
Essay Writing	
The Outline	
Write Essay #1	
Correct Essay #1	
Classification	
Write Essay #2	
Correct Essay #2	
Grammar Problems	
Narrative	
Write Essay #3	
Correct Essay #3	
Comparison—Contrast	
Write Essay #4	
Correct Essay #4	
Process	
Write Essay #5	
Correct Essay #5	
Illustration	
Write Essay #6	
Correct Essay #6	
Description	
Write Essay #7	

Review for Final Exam
Final Exam

Total Lecture Hours	**48**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
   A. Resources: Identifies, organizes, plans, and allocates resources
      1. Allocates time to complete assigned tasks on schedule
      2. Determines and allocates required materials and resources for meeting objectives
      3. Evaluates skills, performance, and quality of work and provides feedback
   B. Interpersonal: Works with others
      1. Participates as a member of the team, contributing to group effort
      2. Provides individual assistance/direction to peers as requested
      3. Determines and meets expectations
      4. Exercises leadership qualities to effectively communicate ideas and make decisions.
      5. Negotiates resources in order to accomplish objectives
      6. Works well with all members of the class
   C. Information: Acquires and uses information
      1. Acquires and evaluates information
      2. Organizes and maintains information
      3. Interprets and communicates information
   D. Systems: Understands complex inter-relationships
      1. Understands and works well with social, organizational, and technological systems
      2. Monitors and corrects performance of system during operation

    3. Recommends modifications to system to improve performance

E. ***Technology:*** *Works with a variety of technologies*

- 1. Chooses relevant procedures, tools, and equipment
- 2. Applies appropriate procedures and techniques to accomplish tasks
- 3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks

- *1.* ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
  - a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
  - b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
  - c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
  - d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
  - e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials
- *2.* ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
  - a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
  - b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
  - c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered

   - d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
   - e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   - a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   - b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   - c. Demonstrates ability to understand and perform multi-step computations
   - d. Demonstrates ability to read, interpret, and use standard measuring devices
   - e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   - f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   - g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines
4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   - a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   - b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   - c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   - d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
   - e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
   - f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed
5. ***Speaking:*** *Organizes ideas and communicates orally*

  - a. Demonstrates appropriate listening and speaking skills in personal conversations
  - b. Demonstrates ability to choose and organize appropriate words to effectively communicate
  - c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
  - d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
  - e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
  - f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
  - g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
    - a. Demonstrates ability to objectively assess personal strengths and weaknesses
    - b. Demonstrates ability to set realistic short-term and long-term goals
    - c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
    - d. Demonstrates ability to identify potential pitfalls and take evasive actions
    - e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
    - f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
    - g. Demonstrates maturity in taking responsibility for decisions
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
    - a. Demonstrates ability to detect problem through observation, inquiry, or directive
    - b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation

- c. Demonstrates ability to generate alternatives or options for problem solution
- d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
- e. Demonstrates ability to initiate and effect solution
- f. Demonstrates ability to take responsibility for outcomes
- g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   - a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   - b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   - c. Demonstrates ability to visually discriminate in gross and fine imagery
   - d. Demonstrates ability to visualize abstractly
   - e. Demonstrates ability to apply visual imagery to applied tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   - a. Demonstrates mastery of basic reading, math, and language skills through application
   - b. Demonstrates ability to translate abstract theory into practical application
   - c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   - d. Demonstrates knowledge of good study skills and learning habits
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   - a. Demonstrates use of simple logic
   - b. Demonstrates ability to distinguish relationships
   - c. Demonstrates ability to determine and isolate factors in relationships
   - d. Demonstrates and applies knowledge through practice
   - e. Recognizes that attitudes, skills, and practice are essential to productivity
   - f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
    a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
    b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
    c. Demonstrates ability to focus on task at hand and work to completion
    d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
    e. Demonstrates maturity to take responsibility for actions
    f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
    a. Presents a positive attitude toward tasks
    b. Demonstrates ability to separate work and personal behaviors
    c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
    d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
    e. Demonstrates ability to accept and use constructive criticism
    f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
    a. Demonstrates appropriate and acceptable social behaviors in interactions
    b. Demonstrates ability to work cooperatively in individual, team, or group situations
    c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
    d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*

a. Accepts personal strengths and weaknesses and uses the same for positive advancement
b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
c. Demonstrates ability to formulate and follow personal schedules
d. Demonstrates ability to wisely use classroom time
e. Demonstrates use of good study habits and skills
f. Demonstrates maturity to take responsibility for own actions

5. *Integrity/Honesty: Chooses ethical courses of action*
    a. Knows and demonstrates ability to distinguish between positive and negative behaviors
    b. Demonstrates honesty and integrity in working with peers and supervisors
    c. Takes full responsibility for personal actions
    d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
    e. Demonstrates positive work and social ethics in undertakings

MASTER Curriculum
Tool and Die Making Technology
(Associate of Applied Science Degree Program)

		LEC	LAB	CR
First Semester*				
TLD 1016	Machine Tool Technology	3	6	6
TLD 1114	Introduction to Die Making Procedures	2	4	4
DDT 1113	Blueprint Reading and Drawing	2	2	3
CPT 1113	Introduction to Computers	2	2	3
MATH 1233	Applied Mathematics for Engineering Technicians	3	0	3
		12	14	19
Second Semester*				
TLD 1133	Die Design I	2	2	3
TLD 1146	Die Making I	3	6	6
TLD 2713	Computer Numerical Control Operations I	2	2	3
DDT 1313	Principles of CAD	2	2	3
ENGL 1113	English Composition I	3	0	3
		12	12	18
Third Semester*				
TLD 2153	Die Design II	2	2	3
TLD 2166	Die Making II	3	6	6
TLD 2723	Computer Numerical Control Operations II	2	2	3
MATH 1323	Trigonometry	3	0	3
SPT 1113	Oral Communications	3	0	3
		13	10	18
Fourth Semester*				
TLD 2174	Die Making III	2	4	4
TLD 2733	Computer Numerical Control Operations III	2	2	3
TLD 2183	Special Project	1	4	3
	Humanities/Fine Arts Elective	3	0	3
	Social or Behavioral Science Elective	3	0	3
		11	10	16
	Program Totals	48	46	71
Optional Courses:				
TLD 2113	Fundamentals of EDM	2	2	3
TLD 2123	Advanced EDM	2	2	3

TLD 2153

MASTER PROGRAM

Die Design II

COURSE SYLLABUS

Total lecture hours: 32 **Total lab hours: 32** **Credit hours: 3**

COURSE DESCRIPTION:

Continues Die Design I with more emphasis on actual die design and construction. Stresses the considerations involved in developing die components, such as calculation of clearances, cutting force, and press tonnage requirements.

PREREQUISITES: **Die Design I**

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:
1. Distinguish between a jig and a fixture and identify types of each;
2. Understand principles of jig and fixture design;
3. Understand principles of die design and theory; and,
4. Make calculations for die design (clearances, tonnage requirements, etc.).

REQUIRED COURSE MATERIALS:

Textbook:	*Basic Diemaking*, D. Eugene Ostergaard, McGraw–Hill Publishers, Latest Edition
Lab Manual:	None

Hand Tools/Quantity Required:

Safety Glasses	1 pair
6 inch Ruler	1/8, 1/16, 1/32, and 1/64 grad.

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a hands–on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Introduction to Die and Fixture Design	
Safety in a Die Shop	
Die Engineering — Planning and Design	
Shear Action in Metal Cutting	
Principles of Blanking/Piercing Dies	
Punch Design and Construction	
Die Block Construction	
Bending of Metals	
Bending and Forming Die Design and Construction	
Strippers and Stock Guides	
Shedders and Knockouts	
Nest Gages, Pushers, and Die Stops	
Compound and Combination Dies	
Progressive Dies	
Stock Material Utilization and Strip Layouts	
Other Types of Industrial Dies	
Total Lecture Hours	32

LAB OUTLINE:

Lab Topics	Contact Hrs.
Introduction to the Design of Dies	1
Safety in the Die Shop	1
Stampings and Their Dies (Visual Survey)	1
Visualization of Die Construction	2
Project (Make Drawing of Existing Die)	5

Project (Design Punch, Punch Plate, and Die Block)	4
Project (Design V–Bend Die)	6
Project (Design Combination Die)	12
Total Lab Hours	**32**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
  - A. *Resources: Identifies, organizes, plans, and allocates resources*
    - 1. Allocates time to complete assigned tasks on schedule
    - 2. Determines and allocates required materials and resources for meeting objectives
    - 3. Evaluates skills, performance, and quality of work and provides feedback
  - B. *Interpersonal: Works with others*
    - 1. Participates as a member of the team, contributing to group effort
    - 2. Provides individual assistance/direction to peers as requested
    - 3. Determines and meets expectations
    - 4. Exercises leadership qualities to effectively communicate ideas and make decisions.
    - 5. Negotiates resources in order to accomplish objectives
    - 6. Works well with all members of the class
  - C. *Information: Acquires and uses information*
    - 1. Acquires and evaluates information
    - 2. Organizes and maintains information
    - 3. Interprets and communicates information
  - D. *Systems: Understands complex inter-relationships*
    - 1. Understands and works well with social, organizational, and technological systems

      2. Monitors and corrects performance of system during operation
      3. Recommends modifications to system to improve performance
   E. Technology: Works with a variety of technologies
      1. Chooses relevant procedures, tools, and equipment
      2. Applies appropriate procedures and techniques to accomplish tasks
      3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS
   A. Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks
      1. Reading: Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules
         a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
         b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
         c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
         d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
         e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials
      2. Writing: Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts
         a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
         b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.

   c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
   d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
   e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. Demonstrates ability to understand and perform multi-step computations
   d. Demonstrates ability to read, interpret, and use standard measuring devices
   e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to oral messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   c. Demonstrates auditory ability to hear, comprehend, and utilize oral classroom as well as other auditory instruction
   d. Demonstrates ability to discriminate between essential and non-essential oral information and react appropriately
   e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds

        - f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed
    - *5.* ***Speaking****: Organizes ideas and communicates orally*
        - a. Demonstrates appropriate listening and speaking skills in personal conversations
        - b. Demonstrates ability to choose and organize appropriate words to effectively communicate
        - c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
        - d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
        - e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
        - f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
        - g. Demonstrates ability to take responsibility for presentations
- B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons
    - *1.* ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
        - a. Demonstrates ability to objectively assess personal strengths and weaknesses
        - b. Demonstrates ability to set realistic short-term and long-term goals
        - c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
        - d. Demonstrates ability to identify potential pitfalls and take evasive actions
        - e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
        - f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
        - g. Demonstrates maturity in taking responsibility for decisions
    - *2.* ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
        - a. Demonstrates ability to detect problem through observation, inquiry, or directive

   - b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   - c. Demonstrates ability to generate alternatives or options for problem solution
   - d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
   - e. Demonstrates ability to initiate and effect solution
   - f. Demonstrates ability to take responsibility for outcomes
   - g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   - a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   - b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   - c. Demonstrates ability to visually discriminate in gross and fine imagery
   - d. Demonstrates ability to visualize abstractly
   - e. Demonstrates ability to apply visual imagery to applied tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   - a. Demonstrates mastery of basic reading, math, and language skills through application
   - b. Demonstrates ability to translate abstract theory into practical application
   - c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   - d. Demonstrates knowledge of good study skills and learning habits
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   - a. Demonstrates use of simple logic
   - b. Demonstrates ability to distinguish relationships
   - c. Demonstrates ability to determine and isolate factors in relationships
   - d. Demonstrates and applies knowledge through practice

        - e. Recognizes that attitudes, skills, and practice are essential to productivity
        - f. Demonstrates ability to discriminate between positive and negative, and act accordingly

- C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty
    - *1.* ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
        - a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
        - b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
        - c. Demonstrates ability to focus on task at hand and work to completion
        - d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
        - e. Demonstrates maturity to take responsibility for actions
        - f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner
    - *2.* ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
        - a. Presents a positive attitude toward tasks
        - b. Demonstrates ability to separate work and personal behaviors
        - c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
        - d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
        - e. Demonstrates ability to accept and use constructive criticism
        - f. Accepts positive reinforcement in an appropriate manner
    - *3.* ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
        - a. Demonstrates appropriate and acceptable social behaviors in interactions
        - b. Demonstrates ability to work cooperatively in individual, team, or group situations
        - c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner

        d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly

4. *Self-Management: Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
    a. Accepts personal strengths and weaknesses and uses the same for positive advancement
    b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
    c. Demonstrates ability to formulate and follow personal schedules
    d. Demonstrates ability to wisely use classroom time
    e. Demonstrates use of good study habits and skills
    f. Demonstrates maturity to take responsibility for own actions
5. *Integrity/Honesty: Chooses ethical courses of action*
    a. Knows and demonstrates ability to distinguish between positive and negative behaviors
    b. Demonstrates honesty and integrity in working with peers and supervisors
    c. Takes full responsibility for personal actions
    d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
    e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
    TLD-B1 through TLD-B5;
    TLD-C1 through TLD-C3;
    TLD-D1 through TLD-D3;
    TLD-F1; and,
    TLD-I1 through TLD-I5.
2. *Machinery's Handbook*, Industrial Press, Latest Edition
3. *Die Design Fundamentals*, J. R. Pacquin and R.E. Crowley, Latest Edition

TLD 2166

MASTER PROGRAM

Die Making II

COURSE SYLLABUS

Total lecture hours: 48 **Total lab hours: 96** **Credit hours: 6**

COURSE DESCRIPTION:

Augments Die Making I with instruction and practice in building a progressive die from a blueprint. Emphasis is placed on the application of the die building procedures learned in Die Making I toward fabricating more complex dies.

PREREQUISITES: **Die Making I**

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:

1. Practice safety in the die shop;
2. Interpret die blueprints;
3. Purchase stock material and buy components;
4. Manufacture and assemble component parts; and,
5. Mount die and perform try–out in press machine.

REQUIRED COURSE MATERIALS:

Textbook:	***Basic Diemaking***, D. Eugene Ostergaard, McGraw–Hill Publishers, Latest Edition
Lab Manual:	None

Hand Tools/Quantity Required:

Safety Glasses	1 pair
6 inch Ruler	1/8, 1/16, 1/32, and 1/64 grad.

METHOD OF INSTRUCTION:

Lecture:	Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a hands–on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Introduction and Safety	
The Progressive Die	
The Die Blueprint	
Component Requirements	
Material Requirements and Specifications	
Calculations Required	
Planning Events	
Total Lecture Hours	48

LAB OUTLINE:

Lab Topics	Contact Hrs.
Orientation and Safety	2
Material Inventory	2
Material Requisitioning for Die	2
Project (Progressive Blank/Pierce Die)	84
Tryout of Die	6
Total Lab Hours	96

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies

required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

- **A.** ***Resources:** Identifies, organizes, plans, and allocates resources*
    1. **Allocates time to complete assigned tasks on schedule**
    2. **Determines and allocates required materials and resources for meeting objectives**
    3. **Evaluates skills, performance, and quality of work and provides feedback**
- **B.** ***Interpersonal:** Works with others*
    1. **Participates as a member of the team, contributing to group effort**
    2. **Provides individual assistance/direction to peers as requested**
    3. **Determines and meets expectations**
    4. **Exercises leadership qualities to effectively communicate ideas and make decisions.**
    5. **Negotiates resources in order to accomplish objectives**
    6. **Works well with all members of the class**
- **C.** ***Information:** Acquires and uses information*
    1. **Acquires and evaluates information**
    2. **Organizes and maintains information**
    3. **Interprets and communicates information**
- **D.** ***Systems:** Understands complex inter-relationships*
    1. **Understands and works well with social, organizational, and technological systems**
    2. **Monitors and corrects performance of system during operation**
    3. **Recommends modifications to system to improve performance**
- **E.** ***Technology:** Works with a variety of technologies*
    1. **Chooses relevant procedures, tools, and equipment**
    2. **Applies appropriate procedures and techniques to accomplish tasks**
    3. **Identifies or solves problems to maintain equipment**

II. FOUNDATION SKILLS

- **A.** **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. ***Reading:** Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
    a. **Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts**
    b. **Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study**
    c. **Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)**
    d. **Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner**
    e. **Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials**
2. ***Writing:** Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
    a. **Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning**
    b. **Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.**
    c. **Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered**
    d. **Demonstrates ability to complete all required writings in a timely, complete, and professional manner**
    e. **Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments**
3. ***Arithmetic/Mathematics:** Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*

   - a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   - b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   - c. Demonstrates ability to understand and perform multi-step computations
   - d. Demonstrates ability to read, interpret, and use standard measuring devices
   - e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   - f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   - g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   - a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to oral messages and instructions and to safely operate machinery
   - b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   - c. Demonstrates auditory ability to hear, comprehend, and utilize oral classroom as well as other auditory instruction
   - d. Demonstrates ability to discriminate between essential and non-essential oral information and react appropriately
   - e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
   - f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed
5. ***Speaking***: *Organizes ideas and communicates orally*
   - a. Demonstrates appropriate listening and speaking skills in personal conversations
   - b. Demonstrates ability to choose and organize appropriate words to effectively communicate
   - c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
   - d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes

    - e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
    - f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
    - g. Demonstrates ability to take responsibility for presentations

- B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons
  - *1.* ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
    - a. Demonstrates ability to objectively assess personal strengths and weaknesses
    - b. Demonstrates ability to set realistic short-term and long-term goals
    - c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
    - d. Demonstrates ability to identify potential pitfalls and take evasive actions
    - e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
    - f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
    - g. Demonstrates maturity in taking responsibility for decisions
  - *2.* ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
    - a. Demonstrates ability to detect problem through observation, inquiry, or directive
    - b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
    - c. Demonstrates ability to generate alternatives or options for problem solution
    - d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
    - e. Demonstrates ability to initiate and effect solution
    - f. Demonstrates ability to take responsibility for outcomes
    - g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. *Seeing Things In the Mind's Eye: Organizes, and processes symbols, pictures, graphs, objects, and other information*
    a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
    b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
    c. Demonstrates ability to visually discriminate in gross and fine imagery
    d. Demonstrates ability to visualize abstractly
    e. Demonstrates ability to apply visual imagery to applied tasks
4. *Knowing How to Learn: Use efficient learning techniques to acquire and apply new knowledge and skills*
    a. Demonstrates mastery of basic reading, math, and language skills through application
    b. Demonstrates ability to translate abstract theory into practical application
    c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
    d. Demonstrates knowledge of good study skills and learning habits
5. *Reasoning: Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
    a. Demonstrates use of simple logic
    b. Demonstrates ability to distinguish relationships
    c. Demonstrates ability to determine and isolate factors in relationships
    d. Demonstrates and applies knowledge through practice
    e. Recognizes that attitudes, skills, and practice are essential to productivity
    f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
    a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals

    b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
    c. Demonstrates ability to focus on task at hand and work to completion
    d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
    e. Demonstrates maturity to take responsibility for actions
    f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
    a. Presents a positive attitude toward tasks
    b. Demonstrates ability to separate work and personal behaviors
    c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
    d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
    e. Demonstrates ability to accept and use constructive criticism
    f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
    a. Demonstrates appropriate and acceptable social behaviors in interactions
    b. Demonstrates ability to work cooperatively in individual, team, or group situations
    c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
    d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
    a. Accepts personal strengths and weaknesses and uses the same for positive advancement
    b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
    c. Demonstrates ability to formulate and follow personal schedules

- d. Demonstrates ability to wisely use classroom time
- e. Demonstrates use of good study habits and skills
- f. Demonstrates maturity to take responsibility for own actions

5. *Integrity/Honesty: Chooses ethical courses of action*
    - a. Knows and demonstrates ability to distinguish between positive and negative behaviors
    - b. Demonstrates honesty and integrity in working with peers and supervisors
    - c. Takes full responsibility for personal actions
    - d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
    - e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
    - TLD-A1 through TLD-A6;
    - TLD-B1 through TLD-B5;
    - TLD-C1 through TLD-C3;
    - TLD-D1 through TLD-D3;
    - TLD-E1 through TLD-E6;
    - TLD-F1 through TLD-F7; and,
    - TLD-I1 through TLD-I7.
2. *Machinery's Handbook,* Industrial Press, Latest Edition
3. *Die Design Fundamentals,* J. R. Pacquin and R.E. Crowley, Latest Edition

TLD 2723

MASTER PROGRAM

Computer Numerical Control Operations II

COURSE SYLLABUS

Total lecture hours: 32 **Total lab hours: 32** **Credit hours: 3**

COURSE DESCRIPTION:

Continues Computer Numerical Control Operations I with additional instruction in writing and editing CNC code manually utilizing more advanced commands and cycles. Additionally, students will be introduced to the use of a Computer–Aided Manufacturing (CAM) system for creation of code.

PREREQUISITES: Computer Numerical Control Operations I

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:

1. Practice safety with CNC equipment;
2. Determine proper tooling, fixtures, and accessories for CNC equipment;
3. Plan sequence of machining events;
4. Set–up, program, and operate CNC machining center (mill);
5. Set–up, program, and operate CNC turning center (lathe); and
6. Use CAM system for programming.

REQUIRED COURSE MATERIALS:

Textbook:	*An Introduction to CNC Machining and Programming,* David Gibbs and Thomas M. Crandell, Industrial Press, Latest Edition
Lab Manual:	Instructor Provided Materials

Hand Tools/Quantity Required:

Safety Glasses	1 pair
6 inch Ruler	1/8, 1/16, 1/32, and 1/64 inch

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a hands-on machining process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Safety with CNC Equipment	
Introduction to CNC Lathe (Industrial Lathe)	
Tooling Systems for CNC Lathes	
Advanced Programming Cycles (CANNED)	
Introduction to CNC Mill (Industrial Mill)	
Tooling Systems for CNC Mills	
Advanced Programming Cycles (CANNED)	
Jigs and Fixtures for CNC Equipment	
Programming for Production and Efficiency	
Introduction to Computer-Aided Manufacturing (CAM)	—
Total Lecture Hours	32

LAB OUTLINE:

Lab Topics	Contact Hrs.
CNC Machines and Safety	1
Operation of CNC Industrial Lathe	2
Tooling Systems	1
Project (Turn and Journal Shaft)	2
Project (Turn Part with Radii, Angles, and Grooves)	3
Project (Threaded Shaft with Tapped End Hole)	3
Operation of CNC Industrial Mill	2
Tooling Systems	1
Project (Drilled and Milled Plate)	2
Project (Milled Plate with Pocket and Name)	3
Project (Production Part for Lathe)	4

Project (Production Part for Mill)		4
Field Trip (CNC Machine Shop)		4
	Total Lab Hours	**32**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
   A. *Resources: Identifies, organizes, plans, and allocates resources*
      1. Allocates time to complete assigned tasks on schedule
      2. Determines and allocates required materials and resources for meeting objectives
      3. Evaluates skills, performance, and quality of work and provides feedback
   B. *Interpersonal: Works with others*
      1. Participates as a member of the team, contributing to group effort
      2. Provides individual assistance/direction to peers as requested
      3. Determines and meets expectations
      4. Exercises leadership qualities to effectively communicate ideas and make decisions.
      5. Negotiates resources in order to accomplish objectives
      6. Works well with all members of the class
   C. *Information: Acquires and uses information*
      1. Acquires and evaluates information
      2. Organizes and maintains information
      3. Interprets and communicates information
   D. *Systems: Understands complex inter-relationships*
      1. Understands and works well with social, organizational, and technological systems
      2. Monitors and corrects performance of system during operation

3. Recommends modifications to system to improve performance

E. ***Technology:*** *Works with a variety of technologies*

1. Chooses relevant procedures, tools, and equipment
2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
    - a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
    - b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
    - c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
    - d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
    - e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials
2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
    - a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
    - b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
    - c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered

   d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
   e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. Demonstrates ability to understand and perform multi-step computations
   d. Demonstrates ability to read, interpret, and use standard measuring devices
   e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines
4. ***Listening:*** *Receives, attends to, interprets, and responds to oral messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to oral messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   c. Demonstrates auditory ability to hear, comprehend, and utilize oral classroom as well as other auditory instruction
   d. Demonstrates ability to discriminate between essential and non-essential oral information and react appropriately
   e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
   f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed
5. ***Speaking*:** *Organizes ideas and communicates orally*

        a. Demonstrates appropriate listening and speaking skills in personal conversations
        b. Demonstrates ability to choose and organize appropriate words to effectively communicate
        c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
        d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
        e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
        f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
        g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

    1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
        a. Demonstrates ability to objectively assess personal strengths and weaknesses
        b. Demonstrates ability to set realistic short-term and long-term goals
        c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
        d. Demonstrates ability to identify potential pitfalls and take evasive actions
        e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
        f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
        g. Demonstrates maturity in taking responsibility for decisions

    2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
        a. Demonstrates ability to detect problem through observation, inquiry, or directive
        b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation

- c. Demonstrates ability to generate alternatives or options for problem solution
- d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
- e. Demonstrates ability to initiate and effect solution
- f. Demonstrates ability to take responsibility for outcomes
- g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   - a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   - b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   - c. Demonstrates ability to visually discriminate in gross and fine imagery
   - d. Demonstrates ability to visualize abstractly
   - e. Demonstrates ability to apply visual imagery to applied tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   - a. Demonstrates mastery of basic reading, math, and language skills through application
   - b. Demonstrates ability to translate abstract theory into practical application
   - c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   - d. Demonstrates knowledge of good study skills and learning habits
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   - a. Demonstrates use of simple logic
   - b. Demonstrates ability to distinguish relationships
   - c. Demonstrates ability to determine and isolate factors in relationships
   - d. Demonstrates and applies knowledge through practice
   - e. Recognizes that attitudes, skills, and practice are essential to productivity
   - f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
    a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
    b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
    c. Demonstrates ability to focus on task at hand and work to completion
    d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
    e. Demonstrates maturity to take responsibility for actions
    f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
    a. Presents a positive attitude toward tasks
    b. Demonstrates ability to separate work and personal behaviors
    c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
    d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
    e. Demonstrates ability to accept and use constructive criticism
    f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
    a. Demonstrates appropriate and acceptable social behaviors in interactions
    b. Demonstrates ability to work cooperatively in individual, team, or group situations
    c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
    d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*

    a. Accepts personal strengths and weaknesses and uses the same for positive advancement
    b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
    c. Demonstrates ability to formulate and follow personal schedules
    d. Demonstrates ability to wisely use classroom time
    e. Demonstrates use of good study habits and skills
    f. Demonstrates maturity to take responsibility for own actions

5. *Integrity/Honesty: Chooses ethical courses of action*
    a. Knows and demonstrates ability to distinguish between positive and negative behaviors
    b. Demonstrates honesty and integrity in working with peers and supervisors
    c. Takes full responsibility for personal actions
    d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
    e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
    TLD-A1 through TLD-A6;
    TLD-B1 through TLD-B5;
    TLD-C1 through TLD-C3;
    TLD-E1 through TLD-E6;
    TLD-F1 through TLD-F5;
    TLD-G1 through TLD-G4;
    TLD-H1 through TLD-H3;
    TLD-H6; and,
    TLD-I1 through TLD-I2.
2. *Machinist Handbook*, Latest Edition
3. *Machinery's Handbook*, Industrial Press, Latest Edition
4. *Machine Tool Practices*, Kibbe, Neely, and Meyer, Wiley Pub., Latest Edition
5. *Technology of Machine Tools*, Steve Krar and Albert Check, Glencoe Publishing, Latest Edition
6. *Student's Shop Reference Handbook*, Edward Hoffman, Industrial Press, Latest Edition
7. *Jig and Fixture Handbook*, Carr Lane Manufacturing Co., Latest Edition

TLD 8725
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MATH 1323

MASTER PROGRAM

Trigonometry

COURSE SYLLABUS

Total lecture hours: 48 **Total lab hours: 0** **Credit hours: 3**

COURSE DESCRIPTION:

Studies solutions of right and oblique triangles, identities, trigonometric equations, and polar and parametric equations.

PREREQUISITE: Intermediate Algebra

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:

1. Sketch an angle in standard position, approximate its measure in degree and radians, and determine the sign of its trigonometric functions;
2. Convert from degree to radian and radian to degree measure;
3. Find the trigonometric functions of a given angle using tables or calculator;
4. Use exact values for trigonometric functions of angles whose reference angle is 30, 45, 60, 0, or 90 degrees;
5. Find the arc length, radius, central angle of a circle;
6. Convert from linear speed to angular velocity and angular velocity to linear speed;
7. Use trigonometric ratios to solve right triangles;
8. Sketch the graphs of trigonometric functions determining amplitude, period, phase shift where applicable;
9. Apply and use in proofs the following identities:
    a. Fundamental identities;
    b. Sum and difference identities;
    c. Double angle identities;
    d. Half angle identities;
    e. Product and factor identities;
10. Define, evaluate, apply the inverse trigonometric functions;
11. Solve trigonometric equations;
12. Apply the law of sine and law of cosines to solving triangles;
13. Find the area of triangles;

14. Use vectors to solve problems in which both magnitude and direction are involved;
15. Convert from rectangular to polar and polar to rectangular coordinates; and,
16. Sketch selected polar functions.

REQUIRED COURSE MATERIALS:

Textbook: *Analytic Trigonometry With Applications*, Barnett, Latest Edition

Supplies:
Notebook Paper
Pencils
Scientific Calculator

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete assignments;
2. Apply theory to assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments, including writing assignments, and oral presentations;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all rules and safety regulations.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
The Trigonometric Functions	
A. Basic Terms of Trigonometry	
B. Definitions of the Trigonometric Functions	
C. Trigonometric Functions of Acute Angles	
D. Trigonometric Functions of Special Angles	
E. Using Reference Angles and the Trigonometric Tables	
F. Solving Right Triangles	
G. Applications of Right Triangles	
Radian Measure	

A. Radian Measure Conversions
B. Formulae for Arc Length and Area of a Sector
C. Linear and Angular Velocity Formulae
D. Circular Functions of Real Numbers

Graphs of Trigonometric Functions

A. Graphs of the Sine and Cosine Functions
B. Horizontal Translations: Phase Shift
C. Graphs of other Trigonometric Functions

Trigonometric Identities

A. Fundamental Identities
B. Verifying Trigonometric Identities
C. Identities Involving Sums and Differences of Two Angles
D. Double and Half-Angle Identities

Inverse Trigonometric Functions and Trigonometric Equations

A. Inverse Functions
B. Inverse Trigonometric Functions
C. Trigonometric Equations
D. Inverse Trigonometric Equations

Oblique Triangles and Vectors

A. Law of Sines
B. The Ambiguous Case: SSA
C. Law of Cosines
D. Vector Applications

Complex Numbers and Polar Coordinates

A. Operations with Complex Numbers
B. Trigonometric Form of a Complex Number
C. Product and Quotient Theorems
D. Powers and Roots of Complex Numbers

Final Exam

Total Lecture Hours 48

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance.

All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
   - A. ***Resources:*** *Identifies, organizes, plans, and allocates resources*
      1. Allocates time to complete assigned tasks on schedule
      2. Determines and allocates required materials and resources for meeting objectives
      3. Evaluates skills, performance, and quality of work and provides feedback
   - B. ***Interpersonal:*** *Works with others*
      1. Participates as a member of the team, contributing to group effort
      2. Provides individual assistance/direction to peers as requested
      3. Determines and meets expectations
      4. Exercises leadership qualities to effectively communicate ideas and make decisions.
      5. Negotiates resources in order to accomplish objectives
      6. Works well with all members of the class
   - C. ***Information:*** *Acquires and uses information*
      1. Acquires and evaluates information
      2. Organizes and maintains information
      3. Interprets and communicates information
   - D. ***Systems:*** *Understands complex inter-relationships*
      1. Understands and works well with social, organizational, and technological systems
      2. Monitors and corrects performance of system during operation
      3. Recommends modifications to system to improve performance
   - E. ***Technology:*** *Works with a variety of technologies*
      1. Chooses relevant procedures, tools, and equipment
      2. Applies appropriate procedures and techniques to accomplish tasks
      3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS
   - A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks
      1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*

- a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
- b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
- c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
- d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
- e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
- a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
- b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
- c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
- d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
- e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
- a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages

- b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
- c. Demonstrates ability to understand and perform multi-step computations
- d. Demonstrates ability to read, interpret, and use standard measuring devices
- e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
- f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
- g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
    - a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
    - b. Demonstrates ability to hear, comprehend, and appropriately follow directions
    - c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
    - d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
    - e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
    - f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed
5. ***Speaking:*** *Organizes ideas and communicates orally*
    - a. Demonstrates appropriate listening and speaking skills in personal conversations
    - b. Demonstrates ability to choose and organize appropriate words to effectively communicate
    - c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
    - d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
    - e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups

    - f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
    - g. Demonstrates ability to take responsibility for presentations

- B. **Thinking Skills:** **Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons**
  - *1.* ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
    - a. Demonstrates ability to objectively assess personal strengths and weaknesses
    - b. Demonstrates ability to set realistic short-term and long-term goals
    - c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
    - d. Demonstrates ability to identify potential pitfalls and take evasive actions
    - e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
    - f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
    - g. Demonstrates maturity in taking responsibility for decisions
  - *2.* ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
    - a. Demonstrates ability to detect problem through observation, inquiry, or directive
    - b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
    - c. Demonstrates ability to generate alternatives or options for problem solution
    - d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
    - e. Demonstrates ability to initiate and effect solution
    - f. Demonstrates ability to take responsibility for outcomes
    - g. Demonstrates ability to effectively problem solve in individual, team, or group situations
  - *3.* ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*

        - a. **Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery**
        - b. **Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues**
        - c. **Demonstrates ability to visually discriminate in gross and fine imagery**
        - d. **Demonstrates ability to visualize abstractly**
        - e. **Demonstrates ability to apply visual imagery to applied tasks**
    - *4.* ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
        - a. **Demonstrates mastery of basic reading, math, and language skills through application**
        - b. **Demonstrates ability to translate abstract theory into practical application**
        - c. **Demonstrates ability to incorporate and generalize new learning into a sequential learning process**
        - d. **Demonstrates knowledge of good study skills and learning habits**
    - *5.* ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
        - a. **Demonstrates use of simple logic**
        - b. **Demonstrates ability to distinguish relationships**
        - c. **Demonstrates ability to determine and isolate factors in relationships**
        - d. **Demonstrates and applies knowledge through practice**
        - e. **Recognizes that attitudes, skills, and practice are essential to productivity**
        - f. **Demonstrates ability to discriminate between positive and negative, and act accordingly**
- C. **Personal Qualities: Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty**
    - *1.* ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
        - a. **Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals**
        - b. **Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner**

- c. Demonstrates ability to focus on task at hand and work to completion
- d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
- e. Demonstrates maturity to take responsibility for actions
- f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:** Believes in own self-worth and maintains a positive view of self*
    - a. Presents a positive attitude toward tasks
    - b. Demonstrates ability to separate work and personal behaviors
    - c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
    - d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
    - e. Demonstrates ability to accept and use constructive criticism
    - f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:** Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
    - a. Demonstrates appropriate and acceptable social behaviors in interactions
    - b. Demonstrates ability to work cooperatively in individual, team, or group situations
    - c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
    - d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:** Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
    - a. Accepts personal strengths and weaknesses and uses the same for positive advancement
    - b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
    - c. Demonstrates ability to formulate and follow personal schedules
    - d. Demonstrates ability to wisely use classroom time
    - e. Demonstrates use of good study habits and skills

    - f. Demonstrates maturity to take responsibility for own actions
- *5. Integrity/Honesty: Chooses ethical courses of action*
    - a. Knows and demonstrates ability to distinguish between positive and negative behaviors
    - b. Demonstrates honesty and integrity in working with peers and supervisors
    - c. Takes full responsibility for personal actions
    - d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
    - e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
   TLD-B1 through TLD-B5.

SPT 1113

MASTER PROGRAM

Oral Communications

COURSE SYLLABUS

Total lecture hours: 48	**Total lab hours: 0**	**Credit hours: 3**

COURSE DESCRIPTION:

Covers correct and effective English; correct pronunciation; breath control; study and practice in making speeches for all occasions with its major emphasis on organization of material; and practice in speaking before the group.

PREREQUISITE: None

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:

1. Employ models to demonstrate communication effectiveness;
2. Develop a self–concept that enhances communication;
3. Engage in effective perception–checking;
4. Distinguish between debilitative and facilitative emotions and demonstrate; methods for managing them;
5. Recognize the role of nonverbal behavior in decoding messages;
6. Demonstrate the use of several effective listening response styles;
7. Identify and describe key aspects of interpersonal relationships;
8. Use feedback to confirm messages;
9. Demonstrate non–defensive responses to criticism; and,
10. Demonstrate the ability to make effective oral presentations.

REQUIRED COURSE MATERIALS:

Textbook: *Public Speaking for College and Career*, Hamilton Gregory, Latest Edition

SUPPLIES: Folder
3 brads

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete assignments;
2. Apply theory to assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments, including writing assignments, and oral presentations;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all rules and safety regulations.

LECTURE OUTLINE

Lecture Topics	Contact Hrs.
Orientation and Overview	
Introduction to Public Speaking	
Controlling Nervousness	
Listening	
Review for Quiz	
Quiz #1	
INTRODUCTORY SPEECH PRESENTATIONS	
Reaching the Audience	
Selecting Topic, Purpose, and Central Idea	
Finding Materials	
Review for Quiz	
Quiz #2	
Supporting Your Ideas	
Visual Aids	
The Body of the Speech	
Quiz #3	
SUPPORT A POINT SPEECH PRESENTATION	
Introductions and Conclusions	
Outlining the Speech	
Speaking to Inform	
Review for Quiz	
Quiz #4	
INFORMATIVE SPEECH PRESENTATION	

Wording the Speech
Delivering the Speech
Speaking to Persuade
Developing the Persuasive Speech
Review for Quiz
Quiz #5
PERSUASIVE SPEECH PRESENTATIONS
Evaluating Speeches
IMPROMPTU SPEECH PRESENTATIONS
Review for Final Exam
Make–Up Week
Final Exam

Total Lecture Hours 48

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
   A. ***Resources:** Identifies, organizes, plans, and allocates resources*
      1. Allocates time to complete assigned tasks on schedule
      2. Determines and allocates required materials and resources for meeting objectives
      3. Evaluates skills, performance, and quality of work and provides feedback
   B. *Interpersonal: Works with others*
      1. Participates as a member of the team, contributing to group effort
      2. Provides individual assistance/direction to peers as requested
      3. Determines and meets expectations
      4. Exercises leadership qualities to effectively communicate ideas and make decisions.

   5. Negotiates resources in order to accomplish objectives
   6. Works well with all members of the class

C. Information: Acquires and uses information
   1. Acquires and evaluates information
   2. Organizes and maintains information
   3. Interprets and communicates information

D. Systems: Understands complex inter-relationships
   1. Understands and works well with social, organizational, and technological systems
   2. Monitors and corrects performance of system during operation
   3. Recommends modifications to system to improve performance

E. Technology: Works with a variety of technologies
   1. Chooses relevant procedures, tools, and equipment
   2. Applies appropriate procedures and techniques to accomplish tasks
   3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks

   1. Reading: Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules
      - a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
      - b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
      - c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
      - d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
      - e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

   2. Writing: Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts

   a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
   b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
   c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
   d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
   e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. Demonstrates ability to understand and perform multi-step computations
   d. Demonstrates ability to read, interpret, and use standard measuring devices
   e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions

- c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
- d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
- e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
- f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. ***Speaking:*** *Organizes ideas and communicates orally*
   - a. Demonstrates appropriate listening and speaking skills in personal conversations
   - b. Demonstrates ability to choose and organize appropriate words to effectively communicate
   - c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
   - d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
   - e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
   - f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
   - g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   - a. Demonstrates ability to objectively assess personal strengths and weaknesses
   - b. Demonstrates ability to set realistic short-term and long-term goals
   - c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
   - d. Demonstrates ability to identify potential pitfalls and take evasive actions
   - e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response

    f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
    g. Demonstrates maturity in taking responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
    a. Demonstrates ability to detect problem through observation, inquiry, or directive
    b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
    c. Demonstrates ability to generate alternatives or options for problem solution
    d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
    e. Demonstrates ability to initiate and effect solution
    f. Demonstrates ability to take responsibility for outcomes
    g. Demonstrates ability to effectively problem solve in individual, team, or group situations
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
    a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
    b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
    c. Demonstrates ability to visually discriminate in gross and fine imagery
    d. Demonstrates ability to visualize abstractly
    e. Demonstrates ability to apply visual imagery to applied tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
    a. Demonstrates mastery of basic reading, math, and language skills through application
    b. Demonstrates ability to translate abstract theory into practical application
    c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
    d. Demonstrates knowledge of good study skills and learning habits

5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. Demonstrates use of simple logic
   b. Demonstrates ability to distinguish relationships
   c. Demonstrates ability to determine and isolate factors in relatiomships
   d. Demonstrates and applies knowledge through practice
   e. Recognizes that attitudes, skills, and practice are essential to productivity
   f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
   c. Demonstrates ability to focus on task at hand and work to completion
   d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
   e. Demonstrates maturity to take responsibility for actions
   f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. Presents a positive attitude toward tasks
   b. Demonstrates ability to separate work and personal behaviors
   c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   e. Demonstrates ability to accept and use constructive criticism
   f. Accepts positive reinforcement in an appropriate manner

3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
    a. Demonstrates appropriate and acceptable social behaviors in interactions
    b. Demonstrates ability to work cooperatively in individual, team, or group situations
    c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
    d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
    a. Accepts personal strengths and weaknesses and uses the same for positive advancement
    b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
    c. Demonstrates ability to formulate and follow personal schedules
    d. Demonstrates ability to wisely use classroom time
    e. Demonstrates use of good study habits and skills
    f. Demonstrates maturity to take responsibility for own actions
5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
    a. Knows and demonstrates ability to distinguish between positive and negative behaviors
    b. Demonstrates honesty and integrity in working with peers and supervisors
    c. Takes full responsibility for personal actions
    d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
    e. Demonstrates positive work and social ethics in undertakings

MASTER Curriculum
Tool and Die Making Technology
(Associate of Applied Science Degree Program)

		LEC	LAB	CR
First Semester*				
TLD 1016	Machine Tool Technology	3	6	6
TLD 1114	Introduction to Die Making Procedures	2	4	4
DDT 1113	Blueprint Reading and Drawing	2	2	3
CPT 1113	Introduction to Computers	2	2	3
MATH 1233	Applied Mathematics for Engineering Technicians	3	0	3
		12	14	19
Second Semester*				
TLD 1133	Die Design I	2	2	3
TLD 1146	Die Making I	3	6	6
TLD 2713	Computer Numerical Control Operations I	2	2	3
DDT 1313	Principles of CAD	2	2	3
ENGL 1113	English Composition I	3	0	3
		12	12	18
Third Semester*				
TLD 2153	Die Design II	2	2	3
TLD 2166	Die Making II	3	6	6
TLD 2723	Computer Numerical Control Operations II	2	2	3
MATH 1323	Trigonometry	3	0	3
SPT 1113	Oral Communications	3	0	3
		13	10	18
Fourth Semester*				
TLD 2174	Die Making III	2	4	4
TLD 2733	Computer Numerical Control Operations III	2	2	3
TLD 2183	Special Project	1	4	3
	Humanities/Fine Arts Elective	3	0	3
	Social or Behavioral Science Elective	3	0	3
		11	10	16
	Program Totals	48	46	71
Optional Courses:				
TLD 2113	Fundamentals of EDM	2	2	3
TLD 2123	Advanced EDM	2	2	3

Fourth Semester

TLD 2174

MASTER PROGRAM

Die Making III

COURSE SYLLABUS

Total lecture hours: 32 **Total lab hours: 64** **Credit hours: 4**

COURSE DESCRIPTION:

Completes Die Making II with instruction and practice in building a compound die from a blueprint. Emphasis is placed on the application of the die building procedures learned in Die Making I and Die Making II toward fabricating more complex dies. Instruction and practice is also given on the use of the Wire Electrical Discharge Machine in the construction of die components.

PREREQUISITES: **Die Making II**

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:

1. Practice safety in the die shop;
2. Interpret die blueprint;
3. Purchase stock material and buy components;
4. Manufacture and assemble component parts; and,
5. Mount die and perform try–out in press machine.

REQUIRED COURSE MATERIALS:

Textbook:	*Basic Diemaking*, D. Eugene Ostergaard, McGraw–Hill Publishers, Latest Edition
Lab Manual:	None

Hand Tools/Quantity Required:

Safety Glasses	1 pair
6 inch Ruler	1/8, 1/16, 1/32, and 1/64 grad.

METHOD OF INSTRUCTION:

Lecture:	Didactic presentations will include lecture, video and demonstrations.
Laboratory:	Laboratory will be a hands–on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

Lecture Topics		Contact Hrs.
Introduction and Safety		
The Compound Die		
The Die Blueprint		
Capabilities of the Wire EDM in Die Building		
Assistance Planning Material		
Requirements and Events		
Assistance with Required Calculations		
Operation of the Wire EDM		
	Total Lecture Hours	32

LAB OUTLINE:

Lab Topics		Contact Hrs.
Orientation and Safety		2
Material Inventory		2
Material Requisitioning for Die		2
Project (Compound Die)		50
Operation of the Wire EDM		4
Tryout of Die		4
	Total Lab Hours	64

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies

required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
   A. ***Resources:*** *Identifies, organizes, plans, and allocates resources*
      1. Allocates time to complete assigned tasks on schedule
      2. Determines and allocates required materials and resources for meeting objectives
      3. Evaluates skills, performance, and quality of work and provides feedback
   B. ***Interpersonal:*** *Works with others*
      1. Participates as a member of the team, contributing to group effort
      2. Provides individual assistance/direction to peers as requested
      3. Determines and meets expectations
      4. Exercises leadership qualities to effectively communicate ideas and make decisions.
      5. Negotiates resources in order to accomplish objectives
      6. Works well with all members of the class
   C. ***Information:*** *Acquires and uses information*
      1. Acquires and evaluates information
      2. Organizes and maintains information
      3. Interprets and communicates information
   D. ***Systems:*** *Understands complex inter-relationships*
      1. Understands and works well with social, organizational, and technological systems
      2. Monitors and corrects performance of system during operation
      3. Recommends modifications to system to improve performance
   E. ***Technology:*** *Works with a variety of technologies*
      1. Chooses relevant procedures, tools, and equipment
      2. Applies appropriate procedures and techniques to accomplish tasks
      3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS
   A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. ***Reading:** Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
    a. **Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts**
    b. **Demonstrates ccurse specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study**
    c. **Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)**
    d. **Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner**
    e. **Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials**
2. ***Writing:** Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
    a. **Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning**
    b. **Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.**
    c. **Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered**
    d. **Demonstrates ability to complete all required writings in a timely, complete, and professional manner**
    e. **Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments**
3. ***Arithmetic/Mathematics:** Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*

   - a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   - b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   - c. Demonstrates ability to understand and perform multi-step computations
   - d. Demonstrates ability to read, interpret, and use standard measuring devices
   - e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   - f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   - g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   - a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to oral messages and instructions and to safely operate machinery
   - b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   - c. Demonstrates auditory ability to hear, comprehend, and utilize oral classroom as well as other auditory instruction
   - d. Demonstrates ability to discriminate between essential and non-essential oral information and react appropriately
   - e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
   - f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. ***Speaking***: *Organizes ideas and communicates orally*
   - a. Demonstrates appropriate listening and speaking skills in personal conversations
   - b. Demonstrates ability to choose and organize appropriate words to effectively communicate
   - c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
   - d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes

    e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
    f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
    g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

  1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
    a. Demonstrates ability to objectively assess personal strengths and weaknesses
    b. Demonstrates ability to set realistic short-term and long-term goals
    c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
    d. Demonstrates ability to identify potential pitfalls and take evasive actions
    e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
    f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
    g. Demonstrates maturity in taking responsibility for decisions
  2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
    a. Demonstrates ability to detect problem through observation, inquiry, or directive
    b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
    c. Demonstrates ability to generate alternatives or options for problem solution
    d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
    e. Demonstrates ability to initiate and effect solution
    f. Demonstrates ability to take responsibility for outcomes
    g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
    a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
    b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
    c. Demonstrates ability to visually discriminate in gross and fine imagery
    d. Demonstrates ability to visualize abstractly
    e. Demonstrates ability to apply visual imagery to applied tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
    a. Demonstrates mastery of basic reading, math, and language skills through application
    b. Demonstrates ability to translate abstract theory into practical application
    c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
    d. Demonstrates knowledge of good study skills and learning habits
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
    a. Demonstrates use of simple logic
    b. Demonstrates ability to distinguish relationships
    c. Demonstrates ability to determine and isolate factors in relationships
    d. Demonstrates and applies knowledge through practice
    e. Recognizes that attitudes, skills, and practice are essential to productivity
    f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
    a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals

   - b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
   - c. Demonstrates ability to focus on task at hand and work to completion
   - d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
   - e. Demonstrates maturity to take responsibility for actions
   - f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. *Self-Esteem: Believes in own self-worth and maintains a positive view of self*
   - a. Presents a positive attitude toward tasks
   - b. Demonstrates ability to separate work and personal behaviors
   - c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   - d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   - e. Demonstrates ability to accept and use constructive criticism
   - f. Accepts positive reinforcement in an appropriate manner

3. *Sociability: Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   - a. Demonstrates appropriate and acceptable social behaviors in interactions
   - b. Demonstrates ability to work cooperatively in individual, team, or group situations
   - c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   - d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly

4. *Self-Management: Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   - a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   - b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   - c. Demonstrates ability to formulate and follow personal schedules

   - d. Demonstrates ability to wisely use classroom time
   - e. Demonstrates use of good study habits and skills
   - f. Demonstrates maturity to take responsibility for own actions

5. *Integrity/Honesty: Chooses ethical courses of action*
   - a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   - b. Demonstrates honesty and integrity in working with peers and supervisors
   - c. Takes full responsibility for personal actions
   - d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   - e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
   TLD-A1 through TLD-A6;
   TLD-B1 through TLD-B5;
   TLD-C1 through TLD-C3;
   TLD-D1 through TLD-D3;
   TLD-E1 through TLD-E6;
   TLD-F1 through TLD-F7;
   TLD-H2 through TLD-H3;
   TLD-H6; and,
   TLD-I1 through TLD-I7.
2. *Machinery's Handbook*, Industrial Press, Latest Edition
3. *Die Design Fundamentals*, J. R. Pacquin and R.E. Crowley, Latest Edition

TLD 2733

MASTER PROGRAM

Computer Numerical Control Operations III

COURSE SYLLABUS

Total lecture hours: 32 **Total lab hours: 32** **Credit hours: 3**

COURSE DESCRIPTION:

Completes Computer Numerical Control Operations I and II with additional instruction and practice in the use of the Computer–Aided Manufacturing (CAM) system for creation of code. Also, the student will be introduced to the Wire Electrical Discharge Machine (EDM) and the Coordinate Measuring Machine (CMM).

PREREQUISITES: Computer Numerical Control Operations II

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:

1. Practice safety with CNC equipment;
2. Determine proper tooling, fixtures, and accessories for CNC equipment;
3. Plan sequence of machining events;
4. Set–up, program, and operate CNC wire EDM; and,
5. Use CAM system for programming.

REQUIRED COURSE MATERIALS:

Textbook: *An Introduction to CNC Machining and Programming*, David Gibbs and Thomas M. Crandell, Industrial Press, Latest Edition

Lab Manual: Instructor Provided Materials

Hand Tools/Quantity Required:

Safety Glasses	1 pair
6 inch Ruler	1/8, 1/16, 1/32, and 1/64 inch

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a hands–on machining process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Safety with CNC Equipment	
Overview of CAM System	
Creating Geometric Elements and Toolpath	
Macros and Automated Roughing Commands	
Postprocessors and Creating Code	
Importing CAD Data into CAM System	
Introduction to Electrical Discharge Machining	
Setup and Operation of the Wire EDM	
Programming the Wire EDM	
Operation of the Coordinate Measuring Machine (CMM)	
Quality Systems and Reverse Engineering	
Total Lecture Hours	**32**

LAB OUTLINE:

Lab Topics	Contact Hrs.
CNC Machines and Safety	1
Installing, Configuring and Modules of CAM System	3
Creating Toolpath with CAM System	6
Project (Lathe Part)	3
Project (Mill Part)	3
Project (Create and Import CAD File to Create Code)	2
Operation of Wire EDM	4
Project (Die Block)	4
Project (Pinion Gear)	4
Project (Die Block with Compound Angles)	6

Operation of CMM	6
Project (Measure Die Block and Compile Data)	6
Total Lab Hours	**32**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
   A. *Resources: Identifies, organizes, plans, and allocates resources*
      1. Allocates time to complete assigned tasks on schedule
      2. Determines and allocates required materials and resources for meeting objectives
      3. Evaluates skills, performance, and quality of work and provides feedback
   B. *Interpersonal: Works with others*
      1. Participates as a member of the team, contributing to group effort
      2. Provides individual assistance/direction to peers as requested
      3. Determines and meets expectations
      4. Exercises leadership qualities to effectively communicate ideas and make decisions.
      5. Negotiates resources in order to accomplish objectives
      6. Works well with all members of the class
   C. *Information: Acquires and uses information*
      1. Acquires and evaluates information
      2. Organizes and maintains information
      3. Interprets and communicates information
   D. *Systems: Understands complex inter-relationships*
      1. Understands and works well with social, organizational, and technological systems
      2. Monitors and corrects performance of system during operation

3. Recommends modifications to system to improve performance

E. Technology: Works with a variety of technologies

1. Chooses relevant procedures, tools, and equipment
2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*

a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts

b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study

c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)

d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner

e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*

a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning

b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.

c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered

d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. Demonstrates ability to understand and perform multi-step computations
   d. Demonstrates ability to read, interpret, and use standard measuring devices
   e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines
4. ***Listening:*** *Receives, attends to, interprets, and responds to oral messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to oral messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   c. Demonstrates auditory ability to hear, comprehend, and utilize oral classroom as well as other auditory instruction
   d. Demonstrates ability to discriminate between essential and non-essential oral information and react appropriately
   e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
   f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed
5. ***Speaking:*** *Organizes ideas and communicates orally*

        - a. Demonstrates appropriate listening and speaking skills in personal conversations
        - b. Demonstrates ability to choose and organize appropriate words to effectively communicate
        - c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
        - d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
        - e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
        - f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
        - g. Demonstrates ability to take responsibility for presentations

- B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons
    - *1.* ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
        - a. Demonstrates ability to objectively assess personal strengths and weaknesses
        - b. Demonstrates ability to set realistic short-term and long-term goals
        - c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
        - d. Demonstrates ability to identify potential pitfalls and take evasive actions
        - e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
        - f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
        - g. Demonstrates maturity in taking responsibility for decisions
    - *2.* ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
        - a. Demonstrates ability to detect problem through observation, inquiry, or directive
        - b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation

c. Demonstrates ability to generate alternatives or options for problem solution
d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
e. Demonstrates ability to initiate and effect solution
f. Demonstrates ability to take responsibility for outcomes
g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. Demonstrates ability to visually discriminate in gross and fine imagery
   d. Demonstrates ability to visualize abstractly
   e. Demonstrates ability to apply visual imagery to applied tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application
   c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. Demonstrates knowledge of good study skills and learning habits
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. Demonstrates use of simple logic
   b. Demonstrates ability to distinguish relationships
   c. Demonstrates ability to determine and isolate factors in relationships
   d. Demonstrates and applies knowledge through practice
   e. Recognizes that attitudes, skills, and practice are essential to productivity
   f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
    - a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
    - b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
    - c. Demonstrates ability to focus on task at hand and work to completion
    - d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
    - e. Demonstrates maturity to take responsibility for actions
    - f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
    - a. Presents a positive attitude toward tasks
    - b. Demonstrates ability to separate work and personal behaviors
    - c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
    - d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
    - e. Demonstrates ability to accept and use constructive criticism
    - f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
    - a. Demonstrates appropriate and acceptable social behaviors in interactions
    - b. Demonstrates ability to work cooperatively in individual, team, or group situations
    - c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
    - d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*

- a. Accepts personal strengths and weaknesses and uses the same for positive advancement
- b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
- c. Demonstrates ability to formulate and follow personal schedules
- d. Demonstrates ability to wisely use classroom time
- e. Demonstrates use of good study habits and skills
- f. Demonstrates maturity to take responsibility for own actions

5. *Integrity/Honesty: Chooses ethical courses of action*
   - a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   - b. Demonstrates honesty and integrity in working with peers and supervisors
   - c. Takes full responsibility for personal actions
   - d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   - e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
   TLD-A1 through TLD-A6;
   TLD-B1 through TLD-B5;
   TLD-C1 through TLD-C3;
   TLD-C5;
   TLD-E1 through TLD-E6;
   TLD-F1 through TLD-F5;
   TLD-G1 through TLD-G4;
   TLD-H1 through TLD-H3;
   TLD-H6;
   TLD-I1 through TLD-I2;
   TLD-J1; and,
   TLD-J4.
2. *Machinery's Handbook,* Industrial Press, Latest Edition
3. *Machine Tool Practices,* Kibbe, Neely, and Meyer, Wiley Pub., Latest Edition
4. *Technology of Machine Tools,* Steve Krar and Albert Check, Glencoe Publishing, Latest Edition
5. *Student's Shop Reference Handbook,* Edward Hoffman, Industrial Press, Latest Edition

TLD 2183

MASTER PROGRAM

Special Project

COURSE SYLLABUS

Total lecture hours: 16 **Total lab hours: 64** **Credit hours: 3**

COURSE DESCRIPTION:

Provides the student with practical application of skills and knowledge gained through other courses in the Tool and Die Technology Program. Students will apply material learned in previous and concurrent classes to design, produce, and test an industrial quality die. Emphasis is placed on the students making decisions, setting priorities and time lines, and realizing the overall responsibility of producing a high–quality product in a given amount of time.

PREREQUISITES: Die Making II

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:

1. Practice safety in the die shop;
2. Interpret die blueprints;
3. Purchase stock material and buy components;
4. Plan sequence of machining events;
5. Set–up and operate all conventional machines in die shop;
6. Set–up, program, and operate CNC machining center, turning center, and wire EDM;
7. Manufacture and assemble component parts; and
8. Trial run tool and/or die.

REQUIRED COURSE MATERIALS:

Textbook: *Basic Diemaking*, D. Eugene Ostergaard, McGraw–Hill Publishers, Latest Edition

Lab Manual: None

Hand Tools/Quantity Required:

Safety Glasses	1 pair
6 inch Ruler	1/8, 1/16, 1/32, and 1/64 grad.

METHOD OF INSTRUCTION:

Lecture:	Didactic presentations will include lecture, video and demonstrations.
Laboratory:	Laboratory will be a hands–on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Introduction and Safety	
Assignment of Project	
Instructor Assistance as Needed	—
Total Lecture Hours	16

LAB OUTLINE:

Lab Topics	Contact Hrs.
Orientation and Safety	1
Project (Design of Progressive Die)	9
Project (Fabrication of Die)	50
Tryout of Die	4
Total Lab Hours	64

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies

required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
  - A. ***Resources:*** *Identifies, organizes, plans, and allocates resources*
    1. Allocates time to complete assigned tasks on schedule
    2. Determines and allocates required materials and resources for meeting objectives
    3. Evaluates skills, performance, and quality of work and provides feedback
  - B. ***Interpersonal:*** *Works with others*
    1. Participates as a member of the team, contributing to group effort
    2. Provides individual assistance/direction to peers as requested
    3. Determines and meets expectations
    4. Exercises leadership qualities to effectively communicate ideas and make decisions.
    5. Negotiates resources in order to accomplish objectives
    6. Works well with all members of the class
  - C. ***Information:*** *Acquires and uses information*
    1. Acquires and evaluates information
    2. Organizes and maintains information
    3. Interprets and communicates information
  - D. ***Systems:*** *Understands complex inter-relationships*
    1. Understands and works well with social, organizational, and technological systems
    2. Monitors and corrects performance of system during operation
    3. Recommends modifications to system to improve performance
  - E. ***Technology:*** *Works with a variety of technologies*
    1. Chooses relevant procedures, tools, and equipment
    2. Applies appropriate procedures and techniques to accomplish tasks
    3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS
  - A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
    a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
    b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
    c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
    d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
    e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials
2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
    a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
    b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
    c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
    d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
    e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments
3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*

a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
c. Demonstrates ability to understand and perform multi-step computations
d. Demonstrates ability to read, interpret, and use standard measuring devices
e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. Listening: Receives, attends to, interprets, and responds to verbal messages and other cues

a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
b. Demonstrates ability to hear, comprehend, and appropriately follow directions
c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. Speaking: Organizes ideas and communicates orally

a. Demonstrates appropriate listening and speaking skills in personal conversations
b. Demonstrates ability to choose and organize appropriate words to effectively communicate
c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation

- d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
- e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
- f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
- g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
    - a. Demonstrates ability to objectively assess personal strengths and weaknesses
    - b. Demonstrates ability to set realistic short-term and long-term goals
    - c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
    - d. Demonstrates ability to identify potential pitfalls and take evasive actions
    - e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
    - f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
    - g. Demonstrates maturity in taking responsibility for decisions
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
    - a. Demonstrates ability to detect problem through observation, inquiry, or directive
    - b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
    - c. Demonstrates ability to generate alternatives or options for problem solution
    - d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
    - e. Demonstrates ability to initiate and effect solution
    - f. Demonstrates ability to take responsibility for outcomes

        - g. Demonstrates ability to effectively problem solve in individual, team, or group situations
    - 3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
        - a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
        - b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
        - c. Demonstrates ability to visually discriminate in gross and fine imagery
        - d. Demonstrates ability to visualize abstractly
        - e. Demonstrates ability to apply visual imagery to applied tasks
    - 4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
        - a. Demonstrates mastery of basic reading, math, and language skills through application
        - b. Demonstrates ability to translate abstract theory into practical application
        - c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
        - d. Demonstrates knowledge of good study skills and learning habits
    - 5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
        - a. Demonstrates use of simple logic
        - b. Demonstrates ability to distinguish relationships
        - c. Demonstrates ability to determine and isolate factors in relationships
        - d. Demonstrates and applies knowledge through practice
        - e. Recognizes that attitudes, skills, and practice are essential to productivity
        - f. Demonstrates ability to discriminate between positive and negative, and act accordingly
- C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty
    - 1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
        - a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals

   - b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
   - c. Demonstrates ability to focus on task at hand and work to completion
   - d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
   - e. Demonstrates maturity to take responsibility for actions
   - f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:** Believes in own self-worth and maintains a positive view of self*
   - a. Presents a positive attitude toward tasks
   - b. Demonstrates ability to separate work and personal behaviors
   - c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   - d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   - e. Demonstrates ability to accept and use constructive criticism
   - f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:** Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   - a. Demonstrates appropriate and acceptable social behaviors in interactions
   - b. Demonstrates ability to work cooperatively in individual, team, or group situations
   - c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   - d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:** Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   - a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   - b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   - c. Demonstrates ability to formulate and follow personal schedules

    - d. Demonstrates ability to wisely use classroom time
    - e. Demonstrates use of good study habits and skills
    - f. Demonstrates maturity to take responsibility for own actions
5. *Integrity/Honesty: Chooses ethical courses of action*
    - a. Knows and demonstrates ability to distinguish between positive and negative behaviors
    - b. Demonstrates honesty and integrity in working with peers and supervisors
    - c. Takes full responsibility for personal actions
    - d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
    - e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
    TLD-A1 through TLD-A6;
    TLD-B1 through TLD-B5;
    TLD-C1 through TLD-C5;
    TLD-D1 through TLD-D3;
    TLD-E1 through TLD-E6;
    TLD-F1 through TLD-F10;
    TLD-G1 through TLD-G4;
    TLD-H2 through TLD-H6; and,
    TLD I1 through TLD-I7.
2. *Machinery's Handbook,* Industrial Press, Latest Edition
3. *Die Design Fundamentals,* J. R. Pacquin and R.E. Crowley, Latest Edition

MASTER Curriculum
Tool and Die Making Technology
(Associate of Applied Science Degree Program)

		LEC	LAB	CR
First Semester*				
TLD 1016	Machine Tool Technology	3	6	6
TLD 1114	Introduction to Die Making Procedures	2	4	4
DDT 1113	Blueprint Reading and Drawing	2	2	3
CPT 1113	Introduction to Computers	2	2	3
MATH 1233	Applied Mathematics for Engineering Technicians	3	0	3
		12	14	19
Second Semester*				
TLD 1133	Die Design I	2	2	3
TLD 1146	Die Making I	3	6	6
TLD 2713	Computer Numerical Control Operations I	2	2	3
DDT 1313	Principles of CAD	2	2	3
ENGL 1113	English Composition I	3	0	3
		12	12	18
Third Semester*				
TLD 2153	Die Design II	2	2	3
TLD 2166	Die Making II	3	6	6
TLD 2723	Computer Numerical Control Operations II	2	2	3
MATH 1323	Trigonometry	3	0	3
SPT 1113	Oral Communications	3	0	3
		13	10	18
Fourth Semester*				
TLD 2174	Die Making III	2	4	4
TLD 2733	Computer Numerical Control Operations III	2	2	3
TLD 2183	Special Project	1	4	3
	Humanities/Fine Arts Elective	3	0	3
	Social or Behavioral Science Elective	3	0	3
		11	10	16
	Program Totals	48	46	71
Optional Courses:				
TLD 2113	Fundamentals of EDM	2	2	3
TLD 2123	Advanced EDM	2	2	3

TLD 2113

MASTER PROGRAM

Fundamentals of EDM

COURSE SYLLABUS

Total lecture hours: 32 **Total lab hours: 32** **Credit hours: 3**

COURSE DESCRIPTION:

This course is an introduction to Electrical Discharge Machining. It includes instruction and practice in the principles of EDM technology as well as the set–up, programming, and operation of sinker and wire EDM.

PREREQUISITES: **Computer Numerical Control Operations III**

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:

1. Explain the principles of Electrical Discharge Machining;
2. Practice safety in the EDM shop;
3. Set–up and operate conventional sinker EDM;
4. Set–up, program, and operate CNC sinker EDM and EDM drill;
5. Set–up, program, and operate CNC wire EDM for 2–axis parts; and,
6. Use the CAM system.

REQUIRED COURSE MATERIALS:

Textbook: None

Lab Manual: Instructor provided

Hand Tools/Quantity Required:
Safety Glasses

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a hands–on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual;

LECTURE OUTLINE:

Lecture Topics	**Contact Hrs.**
Safety in the EDM shop	
Principles of EDM	
Components of the EDM process	
Set–up and operation of the conventional sinker EDM	
Set–up and operation of the CNC sinker EDM	
Programming the CNC sinker EDM	
Set–up and operation of the CNC wire EDM	
Programming the CNC wire EDM	
Using the CAM system for programming EDM systems	—
Total Lecture Hours	**32**

LAB OUTLINE:

Lab Topics	**Contact Hrs.**
EDM safety	
Demonstration of EDM machines, operation, and components	
Set–up and operation of sinker EDM	
Project (EDM holes in steel block)	
Project (EDM simple part with machined electrode)	
Set–up and operation of CNC sinker EDM or drill	
Project (Half-moon electrode)	
Project (Simple gear)	
Set–up and operation of CNC wire EDM	

Project (Simple die block)
Project (Name plate)
Project (Simple gear)

Total Lab Hours 32

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
  - A. *Resources: Identifies, organizes, plans, and allocates resources*
    1. Allocates time to complete assigned tasks on schedule
    2. Determines and allocates required materials and resources for meeting objectives
    3. Evaluates skills, performance, and quality of work and provides feedback
  - B. *Interpersonal: Works with others*
    1. Participates as a member of the team, contributing to group effort
    2. Provides individual assistance/direction to peers as requested
    3. Determines and meets expectations
    4. Exercises leadership qualities to effectively communicate ideas and make decisions.
    5. Negotiates resources in order to accomplish objectives
    6. Works well with all members of the class
  - C. *Information: Acquires and uses information*
    1. Acquires and evaluates information
    2. Organizes and maintains information
    3. Interprets and communicates information
  - D. *Systems: Understands complex inter-relationships*
    1. Understands and works well with social, organizational, and technological systems

2. Monitors and corrects performance of system during operation
3. Recommends modifications to system to improve performance

E. Technology: Works with a variety of technologies

1. Chooses relevant procedures, tools, and equipment
2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks

*1. **Reading:** Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*

  a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
  b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
  c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
  d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
  e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

*2. **Writing:** Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*

  a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
  b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.

c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. Demonstrates ability to understand and perform multi-step computations
   d. Demonstrates ability to read, interpret, and use standard measuring devices
   e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines
4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to oral messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   c. Demonstrates auditory ability to hear, comprehend, and utilize oral classroom as well as other auditory instruction
   d. Demonstrates ability to discriminate between essential and non-essential oral information and react appropriately
   e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds

        - f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed
    - 5. *Speaking: Organizes ideas and communicates orally*
        - a. Demonstrates appropriate listening and speaking skills in personal conversations
        - b. Demonstrates ability to choose and organize appropriate words to effectively communicate
        - c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
        - d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
        - e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
        - f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
        - g. Demonstrates ability to take responsibility for presentations
- B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons
    - *1. Decision Making: Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
        - a. Demonstrates ability to objectively assess personal strengths and weaknesses
        - b. Demonstrates ability to set realistic short-term and long-term goals
        - c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
        - d. Demonstrates ability to identify potential pitfalls and take evasive actions
        - e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
        - f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
        - g. Demonstrates maturity in taking responsibility for decisions
    - *2. Problem Solving: Recognizes problems and devises and implements plan of action*
        - a. Demonstrates ability to detect problem through observation, inquiry, or directive

- b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
- c. Demonstrates ability to generate alternatives or options for problem solution
- d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
- e. Demonstrates ability to initiate and effect solution
- f. Demonstrates ability to take responsibility for outcomes
- g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:** Organizes, and processes symbols, pictures, graphs, objects, and other information*
   - a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   - b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   - c. Demonstrates ability to visually discriminate in gross and fine imagery
   - d. Demonstrates ability to visualize abstractly
   - e. Demonstrates ability to apply visual imagery to applied tasks
4. ***Knowing How to Learn:** Use efficient learning techniques to acquire and apply new knowledge and skills*
   - a. Demonstrates mastery of basic reading, math, and language skills through application
   - b. Demonstrates ability to translate abstract theory into practical application
   - c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   - d. Demonstrates knowledge of good study skills and learning habits
5. ***Reasoning:** Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   - a. Demonstrates use of simple logic
   - b. Demonstrates ability to distinguish relationships
   - c. Demonstrates ability to determine and isolate factors in relationships
   - d. Demonstrates and applies knowledge through practice

        - e. Recognizes that attitudes, skills, and practice are essential to productivity
        - f. Demonstrates ability to discriminate between positive and negative, and act accordingly

- C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty
    - *1.* ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
        - a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
        - b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
        - c. Demonstrates ability to focus on task at hand and work to completion
        - d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
        - e. Demonstrates maturity to take responsibility for actions
        - f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner
    - *2.* ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
        - a. Presents a positive attitude toward tasks
        - b. Demonstrates ability to separate work and personal behaviors
        - c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
        - d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
        - e. Demonstrates ability to accept and use constructive criticism
        - f. Accepts positive reinforcement in an appropriate manner
    - *3.* ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
        - a. Demonstrates appropriate and acceptable social behaviors in interactions
        - b. Demonstrates ability to work cooperatively in individual, team, or group situations
        - c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner

    d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly

4. *Self-Management: Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
    a. Accepts personal strengths and weaknesses and uses the same for positive advancement
    b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
    c. Demonstrates ability to formulate and follow personal schedules
    d. Demonstrates ability to wisely use classroom time
    e. Demonstrates use of good study habits and skills
    f. Demonstrates maturity to take responsibility for own actions
5. *Integrity/Honesty: Chooses ethical courses of action*
    a. Knows and demonstrates ability to distinguish between positive and negative behaviors
    b. Demonstrates honesty and integrity in working with peers and supervisors
    c. Takes full responsibility for personal actions
    d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
    e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
    TLD-A1 through TLD-A6;
    TLD-B1 through TLD-B5;
    TLD-C1 through TLD-C3;
    TLD-D1 through TLD-D3;
    TLD-E1 through TLD-E6;
    TLD-F1;
    TLD-G1 through TLD-G4;
    TLD-H1;
    TLD-I1 through TLD-I2; and,
    TLD-J1 through TLD-J4.
2. *Machinery's Handbook,* Industrial Press, Latest Edition
3. *Student's Shop Reference Handbook,* Edward G. Hoffman, Latest Edition

TLD 2123

MASTER PROGRAM

Advanced EDM

COURSE SYLLABUS

Total lecture hours: 32 **Total lab hours: 32** **Credit hours: 3**

COURSE DESCRIPTION:

This course is a continuation of Fundamentals of EDM Technology with emphasis on 4–axis machining with the CNC wire EDM. Students will be given instruction and practice in the programming of complex parts which utilize the 3rd and 4th axis positioning capabilities of wire EDMs.

PREREQUISITES: **Fundamentals of EDM Technology**

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:
1. Explain principles of electrical discharge machining;
2. Practice safety in the EDM shop; and,
3. Set–up, program, and operate CNC wire EDM for 4–axis parts.

REQUIRED COURSE MATERIALS:

Textbook:	None
Lab Manual:	Instructor provided

METHOD OF INSTRUCTION:

Lecture:	Didactic presentations will include lecture, video and demonstrations.
Laboratory:	Laboratory will be a hands–on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:
1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;

3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual;

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Safety in the EDM shop	
Review of EDM principles	
Set–up and operation of the wire EDM	
Programming the wire EDM (2–axis)	
Using the CAM system for 2–axis parts	
Simultaneous four–axis positioning	
Independent four–axis positioning	
Programming and machining 4–axis parts	
Using the CA system for 4–axis parts	
Total Lecture Hours	**32**

LAB OUTLINE:

Lab Topics	Contact Hrs.
EDM safety	
Set–up and operation of CNC wire EDM	
Project (Die block with holes, slots, and complex shapes)	
Project (Complex shape using CAM system)	
Simultaneous four–axis positioning	
Project (Die block with slug clearance holes)	
Independent four–axis positioning	
Project (Number 1 - 2 transition using CAM system)	
Project (Complex transition using CAM system)	
Project (Complex transition using CAM system)	
Total Lab Hours	**32**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, *full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."*

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
  A. *Resources: Identifies, organizes, plans, and allocates resources*
    1. Allocates time to complete assigned tasks on schedule
    2. Determines and allocates required materials and resources for meeting objectives
    3. Evaluates skills, performance, and quality of work and provides feedback
  B. *Interpersonal: Works with others*
    1. Participates as a member of the team, contributing to group effort
    2. Provides individual assistance/direction to peers as requested
    3. Determines and meets expectations
    4. Exercises leadership qualities to effectively communicate ideas and make decisions.
    5. Negotiates resources in order to accomplish objectives
    6. Works well with all members of the class
  C. *Information: Acquires and uses information*
    1. Acquires and evaluates information
    2. Organizes and maintains information
    3. Interprets and communicates information
  D. *Systems: Understands complex inter-relationships*
    1. Understands and works well with social, organizational, and technological systems
    2. Monitors and corrects performance of system during operation
    3. Recommends modifications to system to improve performance
  E. *Technology: Works with a variety of technologies*
    1. Chooses relevant procedures, tools, and equipment
    2. Applies appropriate procedures and techniques to accomplish tasks
    3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS
  A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. *Reading: Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
    a. **Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts**
    b. **Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study**
    c. **Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)**
    d. **Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner**
    e. **Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials**
2. *Writing: Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
    a. **Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning**
    b. **Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.**
    c. **Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered**
    d. **Demonstrates ability to complete all required writings in a timely, complete, and professional manner**
    e. **Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments**
3. *Arithmetic/Mathematics: Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*

   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. Demonstrates ability to understand and perform multi-step computations
   d. Demonstrates ability to read, interpret, and use standard measuring devices
   e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. *Listening: Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to oral messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   c. Demonstrates auditory ability to hear, comprehend, and utilize oral classroom as well as other auditory instruction
   d. Demonstrates ability to discriminate between essential and non-essential oral information and react appropriately
   e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
   f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed
5. *Speaking: Organizes ideas and communicates orally*
   a. Demonstrates appropriate listening and speaking skills in personal conversations
   b. Demonstrates ability to choose and organize appropriate words to effectively communicate
   c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
   d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes

- e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
- f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
- g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
    - a. Demonstrates ability to objectively assess personal strengths and weaknesses
    - b. Demonstrates ability to set realistic short-term and long-term goals
    - c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
    - d. Demonstrates ability to identify potential pitfalls and take evasive actions
    - e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
    - f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
    - g. Demonstrates maturity in taking responsibility for decisions
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
    - a. Demonstrates ability to detect problem through observation, inquiry, or directive
    - b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
    - c. Demonstrates ability to generate alternatives or options for problem solution
    - d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
    - e. Demonstrates ability to initiate and effect solution
    - f. Demonstrates ability to take responsibility for outcomes
    - g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. *Seeing Things In the Mind's Eye: Organizes, and processes symbols, pictures, graphs, objects, and other information*
    a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
    b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
    c. Demonstrates ability to visually discriminate in gross and fine imagery
    d. Demonstrates ability to visualize abstractly
    e. Demonstrates ability to apply visual imagery to applied tasks
4. *Knowing How to Learn: Use efficient learning techniques to acquire and apply new knowledge and skills*
    a. Demonstrates mastery of basic reading, math, and language skills through application
    b. Demonstrates ability to translate abstract theory into practical application
    c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
    d. Demonstrates knowledge of good study skills and learning habits
5. *Reasoning: Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
    a. Demonstrates use of simple logic
    b. Demonstrates ability to distinguish relationships
    c. Demonstrates ability to determine and isolate factors in relationships
    d. Demonstrates and applies knowledge through practice
    e. Recognizes that attitudes, skills, and practice are essential to productivity
    f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. Personal Qualities: Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty
1. *Responsibility: Exerts a high level of effort and perseveres towards goal attainment*
    a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals

  - b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
  - c. Demonstrates ability to focus on task at hand and work to completion
  - d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
  - e. Demonstrates maturity to take responsibility for actions
  - f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   - a. Presents a positive attitude toward tasks
   - b. Demonstrates ability to separate work and personal behaviors
   - c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   - d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   - e. Demonstrates ability to accept and use constructive criticism
   - f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   - a. Demonstrates appropriate and acceptable social behaviors in interactions
   - b. Demonstrates ability to work cooperatively in individual, team, or group situations
   - c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   - d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   - a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   - b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   - c. Demonstrates ability to formulate and follow personal schedules

    d. Demonstrates ability to wisely use classroom time
    e. Demonstrates use of good study habits and skills
    f. Demonstrates maturity to take responsibility for own actions

5. *Integrity/Honesty: Chooses ethical courses of action*
    a. Knows and demonstrates ability to distinguish between positive and negative behaviors
    b. Demonstrates honesty and integrity in working with peers and supervisors
    c. Takes full responsibility for personal actions
    d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
    e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
    TLD-A1 through TLD-A6;
    TLD-B1 through TLD-B5;
    TLD-C1 through TLD-C3;
    TLD-D1 through TLD-D3;
    TLD-E1 through TLD-E6;
    TLD-F1;
    TLD-G1 through TLD-G4;
    TLD-H1;
    TLD-H4;
    TLD-H6;
    TLD-I1 through TLD-I2;
    TLD-J1; and,
    TLD-J3 through TLD-J4.
2. *Machinery's Handbook,* Industrial Press, Latest Edition
3. *Student's Shop Reference Handbook,* Edward G. Hoffman, Latest Edition

MACHINE TOOL ADVANCED SKILLS TECHNOLOGY EDUCATIONAL RESOURCES

MASTER

a consortium of educators and industry

EDUCATIONAL RESOURCES
FOR THE
MACHINE TOOL INDUSTRY

Tool & Die and EDM Series
INSTRUCTOR'S HANDBOOK

Supported by the National Science Foundation's Advanced Technological Education Program

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MASTER Consortia of Employers and Educators

MASTER has built upon the foundation which was laid by the Machine Tool Advanced Skills Technology (MAST) Program. The MAST Program was supported by the U.S. Department of Education - Office of Vocational and Adult Education. Without this prior support MASTER could not have reached the level of quality and quantity that is contained in these project deliverables.

MASTER DEVELOPMENT CENTERS
Augusta Technical Institute - Central Florida Community College - Itawamba Community College - Moraine Valley Community College - San Diego City College (CACT) - Springfield Technical Community College - Texas State Technical College

INDUSTRIES
AB Lasers - AIRCAP/MTD - ALCOA - American Saw - AMOCO Performance Products - Automatic Switch Company - Bell Helicopter - Bowen Tool - Brunner - Chrysler Corp. - Chrysler Technologies - Conveyor Plus - Darr Caterpillar - Davis Technologies - Delta International - Devon - D. J. Plastics - Eaton Leonard - EBTEC - Electro-Motive - Emergency One - Eureka - Foster Mold - GeoDiamond/Smith International - Greenfield Industries - Hunter Douglas - Industrial Laser - ITT Engineered Valve - Kaiser Aluminum - Krueger International. - Laser Fare - Laser Services - Lockheed Martin - McDonnell Douglas - Mercury Tool - NASSCO - NutraSweet - Rapistan DEMAG - Reed Tool - ROHR, International - Searle - Solar Turbine - Southwest Fabricators - Smith & Wesson - Standard Refrigeration - Super Sagless - Taylor Guitars - Tecumseh - Teledyne Ryan - Thermal Ceramics - Thomas Lighting - FMC, United Defense - United Technologies Hamilton Standard

COLLEGE AFFILIATES
Aiken Technical College - Bevil Center for Advanced Manufacturing Technology - Chicago Manufacturing Technology Extension Center - Great Lakes Manufacturing Technology Center - Indiana Vocational Technical College - Milwaukee Area Technical College - Okaloosa-Walton Community College - Piedmont Technical College - Pueblo Community College - Salt Lake Community College - Spokane Community College - Texas State Technical Colleges at Harlington, Marshall, Sweetwater

FEDERAL LABS
Jet Propulsion Lab - Lawrence Livermore National Laboratory - L.B.J. Space Center (NASA) - Los Alamos Laboratory - Oak Ridge National Laboratory - Sandia National Laboratory - Several National Institute of Standards and Technology Centers (NIST) - Tank Automotive Research and Development Center (TARDEC) - Wright Laboratories

SECONDARY SCHOOLS
Aiken Career Center - Chicopee Comprehensive High School - Community High School (Moraine, IL) - Connally ISD - Consolidated High School - Evans High - Greenwood Vocational School - Hoover Sr. High - Killeen ISD - LaVega ISD - Lincoln Sr. High - Marlin ISD - Midway ISD - Moraine Area Career Center - Morse Sr. High - Point Lamar Sr. High -

Pontotoc Ridge Area Vocational Center - Putnam Vocational High School - San Diego Sr. High - Tupelo-Lee Vocational Center - Waco ISD - Westfield Vocational High School

ASSOCIATIONS

American Vocational Association (AVA) - Center for Occupational Research and Development (CORD) - CIM in Higher Education (CIMHE) - Heart of Texas Tech-Prep - Midwest (Michigan) Manufacturing Technology Center (MMTC) - National Coalition For Advanced Manufacturing (NACFAM) - National Coalition of Advanced Technology Centers (NCATC) - National Skills Standards Pilot Programs - National Tooling and Machining Association (NTMA) - New York Manufacturing Extension Partnership (NYMEP) - Precision Metalforming Association (PMA) - Society of Manufacturing Engineers (SME) - Southeast Manufacturing Technology Center (SMTC)

MASTER PROJECT EVALUATORS

Dr. James Hales, East Tennessee State University and William Ruxton, formerly with the National Tooling and Machine Association (NTMA)

NATIONAL ADVISORY COUNCIL MEMBERS

The National Advisory Council has provided input and guidance into the project since the beginning. Without their contributions, MASTER could not have been nearly as successful as it has been. Much appreciation and thanks go to each of the members of this committee from the project team.

Dr. Hugh Rogers-Dean of Technology-Central Florida Community College
Dr. Don Clark-Professor Emeritus-Texas A&M University
Dr. Don Edwards-Department of Management-Baylor University
Dr. Jon Botsford-Vice President for Technology-Pueblo Community College
Mr. Robert Swanson-Administrator of Human Resources-Bell Helicopter, TEXTRON
Mr. Jack Peck-Vice President of Manufacturing-Mercury Tool & Die
Mr. Don Hancock-Superintendent-Connally ISD

SPECIAL RECOGNITION

Dr. Hugh Rogers recognized the need for this project, developed the baseline concepts and methodology, and pulled together industrial and academic partners from across the nation into a solid consortium. Special thanks and singular congratulations go to Dr. Rogers for his extraordinary efforts in this endeavor.

Dr. Don Pierson served as the Principal Investigator for the first two years of MASTER. His input and guidance of the project during the formative years was of tremendous value to the project team. Special thanks and best wishes go to Dr. Pierson during his retirement and all his worldly travels.

All findings and deliverables resulting from MASTER are primarily based upon information provided by the above companies, schools and labs. We sincerely thank key personnel within these organizations for their commitment and dedication to this project. Including the national survey, more than 2,800 other companies and organizations participated in this project. We commend their efforts in our combined attempt to reach some common ground in precision manufacturing skills standards and curriculum development.

MASTER DEVELOPMENT CENTER, TUPELO, MS
Itawamba Community College
Tupelo Campus

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Itawamba Community College
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Don Benjamin, Associate Dean
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Manufacturing in Mississippi

Evolving from a previously agrarian economy, the region served by Itawamba Community College now contains a significant industrial base. Approximately 45% of employed adults in the surrounding area work in manufacturing, with the predominant industries including metal-working, machinery, paper products, rubber/plastics, electrical components, furniture, apparel, and wood products. About 35-40% of all manufacturing employees work in the furniture industry. After World War II, several major metal-working companies established branch plants in the Tupelo area, a trend that has continued into the 1990's. Between 1975 and 1980, pressures of competition and technology caused a number of these companies to reconsider their continued presence in northern Mississippi, spurring action by regional economic development organizations to preserve an employment and tax base essential to the community. Many of their economic development initiatives involved the community college, leading directly to the establishment of its Tool and Die Making Technology program and introduction of training in CAD, CNC, robotics, and lasers.

Itawamba Community College

Itawamba Community College (ICC) provides university transfer programs, associate degree career programs, non-credit customized industry training, and continuing education to a rural five-county area in northeast Mississippi. Of the local population of approximately 170,000 persons, 79% are white and 19% black; the student profile at the College roughly mirrors the racial composition of the general population, and a high percentage of students are from low-income households. The mission of the College includes the mandate to provide "educational services which contribute to the needs of new, expanding, or existing businesses and industries and to the training needs of the people." Accordingly, the College's instructional programs are designed with national trends and the needs of business and industry in mind, and the objective of all courses and training is to provide both students and companies with what they need to succeed. The main campus is in Fulton and the vocational-technical campus in Tupelo.

Development Team

- **Project Director:** Don Benjamin, Associate Dean of Career Education, served as program manager and academic coordinator for the MASTER project.
- **Site Coordinator**: Barry Emison was responsible for industrial assessment and skills validation, as well as development of skill standards and course/program materials for the Tool and Die Technology component of the MASTER project.
- **Subject Matter Experts**: Several college academic and technology instructors served as advisors for basic academic competencies, sharing responsibility with Mr. Emison for compiling data from industry surveys and interviews during the skill standards development process. Donald Taylor and Terry Kitchens, Tool and Die Technology Instructors, served as technical advisors for workplace competencies and developed course curricula and program materials. They also served as co-instructors and coordinators for the MASTER pilot program in Tool and Die Technology.

Introduction:
INSTRUCTOR'S HANDBOOK

Prior to the development of this Instructor's Handbook, **MASTER** project staff visited over 150 companies, conducted interviews with over 500 expert workers, and analyzed data from a national survey involving over 2800 participating companies. These investigations led to the development of a series of Instructor Handbooks, with each being fully industry-driven and specific to one of the technologies shown below.

Advanced CNC and CAM
Automated Equipment Repair
Computer Aided Design & Drafting
Conventional Machining
Industrial Maintenance
Instrumentation
LASER Machining
Manufacturing Technology
Mold Making
Tool And Die
Welding

Each Instructor's Handbook contains a collection of Technical Training Modules which are built around a Competency Profile for the specific occupation. **The Competency Profile which is the basis for this Instructor's Handbook, may be found on the following page (and on each of the tab pages of this book).**

Each Technical Training Module has been designed to be:

- Based on skill standards specified by industry. There must be a direct correlation between what industry needs and what is taught in the classroom and in the laboratory. For many years this type of training has been known as "competency-based training".

- Generic in nature. The training materials may then be customized by the trainer, for any given training situation based on the training need.

- Modular in design, to allow trainers to select lessons which are applicable to their training needs.

- Comprehensive, include training for advanced and emerging, highly-specialized manufacturing technologies.

- Self-contained, including all the components which might be needed by an experienced trainer. These components might include any or all of the following:
  - a standardized lesson plan,
  - an assessment instrument,
  - a listing of commercially available resources (e.g. recommended textbooks, instructor guides, student manuals, and videos),
  - new training materials, when suitable existing materials are not available (e.g., classroom handouts, transparency masters, and laboratory exercises).

This Instructor's Handbook is arranged by Duty groupings (Duty A, Duty B, etc.) with technical modules developed for each Task Box on the Competency Profile. Trainers are free to choose modules for a specific training need and combine modules to build individualized training programs.

This Instructor's Handbook is being offered with an accompanying Student Laboratory Manual for use by the students enrolled in the training program.

TOOL AND DIE MAKER .... skilled workers who produce tools, dies, and special guiding and holding devices that are used in machining.

	Duties	Tasks												
A	Practice Safety	A-1 Follow safety manuals and all safety regulations/ requirements	A-2 Maintain safe equipment and machinery	A-3 Use safe operating procedures for hand and machine tools	A-4 Maintain a clean and safe work environment	A-5 Use safe material handling practices	A-6 Consult and apply MSDS for hazards of various materials							
B	Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Perform basic algebraic operations	B-3 Use basic geometric principles	B-4 Perform basic trigonometric functions	B-5 Use and apply Cartesian Coordinate System								
C	Interpret Engineering Drawings and Related Documents	C-1 Interpret and understand basic layout/types of drawings	C-2 Interpret, review, and apply blueprint notes, dimensions, and tolerances	C-3 Use and apply Geometric Dimensioning and Tolerancing (GD&T)	C-4 Demonstrate traditional mechanical drafting and sketching techniques	C-5 Understand and use quality systems								
D	Demonstrate Knowledge of Manufacturing Materials	D-1 Identify materials with desired properties	D-2 Identify materials and processes to produce a part	D-3 Discuss classification systems for metal										
E	Measure/ Inspect	E-1 Understand metrology terms	E-2 Select measurement tools	E-3 Measure with hand held instruments	E-4 Eliminate measurement variables	E-5 Measure/inspect using surface plate and accessories	E-6 Inspect using stationary equipment							
F	Demonstrate Knowledge of Manufacturing Processes	F-1 Discuss metal cutting and metal cutting tools	F-2 Operate metal saws	F-3 Operate drill presses and tooling	F-4 Operate engine and turret lathes and tooling	F-5 Operate vertical and horizontal mills and tooling	F-6 Operate precision grinders	F-7 Operate heat treating equipment and processes	F-8 Operate sheet metal equipment	F-9 Operate welding equipment and processes	F-10 Estimate time required/ cost to produce a part			
G	Use Computers	G-1 Use computer operating systems	G-2 Understand computer terminology	G-3 Use file management systems	G-4 Install and use software packages									
H	Perform CAD/ CAM and CNC Programming Tasks	H-1 Discuss fundamentals of CNC machines and controls	H-2 Program and operate CNC milling machine and machining center	H-3 Program and operate CNC lathe	H-4 Use Computer-Aided Drafting (CAD) system	H-5 Create 3-D solid models	H-6 Use Computer-Aided Manufacturing (CAM) system							
I	Perform Tool and Die Making Operations	I-1 Discuss basic types and functions of jigs and fixtures	I-2 Utilize concepts of jig and fixture design	I-3 Demonstrate understanding of different types of industrial dies	I-4 Utilize basic die theory	I-5 Utilize principles of die design	I-6 Perform tool and die repair	I-7 Demonstrate tool and die making skills						
J	Operate Electrical Discharge Machine (EDM)	J-1 Discuss fundamentals of EDM	J-2 Setup and operate conventional sinker EDM	J-3 Program, setup, and operate CNC sinker EDM and EDM drill	J-4 Program, setup, and operate CNC wire EDM									

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TOOL AND DIE MAKER .... skilled workers who produce tools, dies, and special guiding and holding devices that are used in machining.

Duties ← **Tasks** →

A	Practice Safety	A-1 Follow safety manuals and all safety regulations/ requirements	A-2 Maintain safe equipment and machinery	A-3 Use safe operating procedures for hand and machine tools	A-4 Maintain a clean and safe work environment	A-5 Use safe material handling practices	A-6 Consult and apply MSDS for hazards of various materials							
B	Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Perform basic algebraic operations	B-3 Use basic geometric principles	B-4 Perform basic trigonometric functions	B-5 Use and apply Cartesian Coordinate System								
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D	Demonstrate Knowledge of Manufacturing Materials	D-1 Identify materials with desired properties	D-2 Identify materials and processes to produce a part	D-3 Discuss classification systems for metal										
E	Measure/ Inspect	E-1 Understand metrology terms	E-2 Select measurement tools	E-3 Measure with hand held instruments	E-4 Eliminate measurement variables	E-5 Measure/Inspect using surface plate and accessories	E-6 Inspect using stationary equipment							
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J	Operate Electrical Discharge Machine (EDM)	J-1 Discuss fundamentals of EDM	J-2 Setup and operate conventional sinker EDM	J-3 Program, setup, and operate CNC sinker EDM and EDM drill	J-4 Program, setup, and operate CNC wire EDM									

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Duty A

TLD-A1

TOOL & DIE and EDM SERIES
MASTER Technical Module No. TLD-A1

Subject: **Tool & Die and EDM** **Time: 2 Hrs.**

Duty: **Practice Safety**
Task: Follow Safety Manuals and All Safety Regulations/ Requirements

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Objective(s):

Upon completion of this unit the student will be able to:
a. Assume responsibility for the personal safety of oneself and others;
b. Develop a personal attitude towards safety;
c. Interpret safety manual directives;
d. Identify and control common machine shop hazards; and,
e. Comply with established company safety practices.

Instructional Materials:

MASTER Handout (TLD-A1-HO)
MASTER Laboratory Exercise (TLD-A1-LE)
MASTER Laboratory Aid (TLD-A1-LA)
MASTER Self-Assessment

References:

Specific Company Safety Policy and Procedures Manual
OSHA General Industry Requirements, U. S. Government Printing Office, Latest Edition

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Student Preparation:

All students must prepare themselves to enhance their attitudes toward safety. Such preparation may begin by the students asking themselves the following basic questions daily:

1. Is my hair properly stowed to prevent accidents?
2. Am I wearing any jewelry?
3. Do I have the proper shoes?
4. Do I have my eye shields (safety glasses)?
5. Is my work area free of debris and clean?
6. Does my machine have all its safeguards?
7. Is my machine working properly?
8. Do I know where the nearest fire extinguisher is?

Introduction:

Safety on the job is not only the responsibility of the management of the company. While management must establish rules according to regulations that the government has set forth for your industry, and while they must enforce these rules, every employee must be taught what these rules are and how to obey them. However, the responsibility for safety is in your hands. You are the person closest to the work being performed. Learn and follow all rules. Never take short cuts or chances. Make safety your way of life.

Presentation Outline:

- I. Assume Responsibility for the Personal Safety of Oneself and Others
  - A. Safety is a way of life not an option
  - B. Always operate with alertness and safety foremost in mind
- II. Develop a Personal Attitude Towards Safety
  - A. The key to safety is individual safety
  - B. Everyone must develop a safe attitude
  - C. Each step of the operation must be carefully planned
- III. Interpret Safety Manual Directives
  - A. Read and understand safety manual
  - B. Read machine operation instructions
- IV. Comply with Established Safety Practices
  - A. Personal safety
    - 1. Body: keep body out of line of tool edge
    - 2. Proper lifting technique
      - a. Personal lifting
        - 1) Lift with the legs, not the back
        - 2) Proper physical position while lifting
        - 3) Proper clearance for carrying
        - 4) "Buddy system" for heavy lifting
      - b. Equipment lifting
        - 1) Checking ratings for lifting devices
        - 2) Checking lifting points on lifted item
        - 3) Overhead clearance requirements
        - 4) Static lifting devices (slings, jack stands) should be used instead of moving lifting devices (jacks or forklifts) for actually holding heavy items up while working on them
  - B. Eyes: always wear safety glasses
  - C. Head: keep long hair up; wear hard hat whenever required
  - D. Ears: wear protection to prevent damage from noise
  - E. Jewelry: no rings, watches, bracelets, necklaces (they can get caught in machinery and they are conductors of electricity)

    - F. Clothing: keep sleeves and pant legs rolled down; and ties, strings, and belts away from moving parts
    - G. No horse-play
    - H. Do not talk to someone while that person is operating a machine
    - I. Do not talk to someone while you are operating a machine
- V. Identify and Control Common Machine Shop Hazards
    - A. Chip formation
    - B. Moving machine parts
    - C. Spills and other debris
    - D. Electrical lines
    - E. Hydraulic and pneumatic lines
- VI. Cover specific safety policies of the company

Practical Application:

The students must demonstrate a practical and aware attitude toward safety in the workplace at all times. No careless or unsafe behavior is acceptable.

NB: The laboratory exercise for this module is to be completed *before* the instruction begins. Laboratory Exercise TLD-A1-LE ties directly to the final laboratory exercise in the TLD-A Safety series.

Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-A2) dealing with maintaining safe equipment and machinery.

TLD-A1-HO
Follow Safety Manuals and All Safety Regulations/Requirements
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:
- a. Assume responsibility for the personal safety of oneself and others;
- b. Develop a personal attitude towards safety;
- c. Interpret safety manual directives;
- d. Identify and control common machine shop hazards; and,
- e. Comply with established company safety practices.

Module Outline:

- I. Assume Responsibility for the Personal Safety of Oneself and Others
  - A. Safety is a way of life not an option
  - B. Always operate with alertness and safety foremost in mind
- II. Develop a Personal Attitude Towards Safety
  - A. The key to safety is individual safety
  - B. Everyone must develop a safe attitude
  - C. Each step of the operation must be carefully planned
- III. Interpret Safety Manual Directives
  - A. Read and understand safety manual
  - B. Read machine operation instructions
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  - A. Personal safety
    - 1. Body: keep body out of line of tool edge
    - 2. Proper lifting technique
      - a. Personal lifting
        - 1) Lift with the legs, not the back
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        - 3) Proper clearance for carrying
        - 4) "Buddy system" for heavy lifting
      - b. Equipment lifting
        - 1) Checking ratings for lifting devices
        - 2) Checking lifting points on lifted item
        - 3) Overhead clearance requirements
        - 4) Static lifting devices (slings, jack stands) should be used instead of moving lifting devices (jacks or forklifts) for actually holding heavy items up while working on them
  - B. Eyes: always wear safety glasses
  - C. Head: keep long hair up; wear hard hat whenever required

    - D. Ears: wear protection to prevent damage from noise
    - E. Jewelry: no rings, watches, bracelets, necklaces (they can get caught in machinery and they are conductors of electricity)
    - F. Clothing: keep sleeves and pant legs rolled down; and ties, strings, and belts away from moving parts
    - G. No horse-play
    - H. Do not talk to someone while that person is operating a machine
    - I. Do not talk to someone while you are operating a machine
- V. Identify and Control Common Machine Shop Hazards
    - A. Chip formation
    - B. Moving machine parts
    - C. Spills and other debris
    - D. Electrical lines
    - E. Hydraulic and pneumatic lines
- VI. Cover specific safety policies of the company

TLD-A1-LE

Follow Safety Manuals and All Safety Regulations/Requirements

Attachment 2: MASTER Laboratory Exercise

The purpose of this exercise is to learn to recognize hazards in the workplace. Many of the hazards which you will find there are common practices by people who simply no longer see the danger.

The instructor will guide all students through part of the facility. Each student should write down, in the space provided below, as many safety hazards as are found.

Remember, anyone can cause a hazard merely by failing to see the mop bucket that sits in front of the fire exit every day. Such tunnel vision is the result of familiarity and demonstrates the importance of keeping a fresh perspective *everyday*.

Due to the nature of this laboratory exercise, no answer key is possible.

Safety Hazards

Type	Location	Description

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and,
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

Name__________________________ Date_______________

TLD-A1

Follow Safety Manuals and All Safety Regulations/Requirements

Self-Assessment

Circle the letter preceding the correct answer.

1. A positive attitude towards safety:
   - A. Is the responsibility of the individual.
   - B. Is the responsibility of management.
   - C. Can be developed by all workers, regardless of their work.
   - D. All of the above
   - E. None of the above answers is correct.

2. When is jewelry permitted to be worn?
   - A. On slow moving machinery
   - B. If all guards are in place
   - C. Never
   - D. If your supervisor knows
   - E. None of the above answers is correct.

3. Most accidents occur because:
   - A. Almost every tool is unsafe.
   - B. There is an unsafe condition and an unsafe action.
   - C. Workers lack motivation.
   - D. There is a practical joker in every plant.
   - E. None of the above answers is correct.

4. Who is responsible for safety on the job?
   - A. Management and employees
   - B. Employees
   - C. Union
   - D. Government
   - E. None of the above answers is correct.

5. Your most important motivation for working safely is to:
   - A. Get a raise.
   - B. Avoid being suspended.
   - C. Protect yourself.
   - D. Avoid working too hard.
   - E. None of the above answers is correct.

6. Your best protection against accidents is often:
   A. Alertness.
   B. Union policy.
   C. Close supervision.
   D. Buddy system.
   E. None of the above answers is correct.

7. Which of the following three things is more important than natural skill in doing a job well and safely?
   A. Training
   B. Attitude
   C. Alertness
   D. All of the above
   E. None of the above answers is correct.

8. When you spot something dangerous in your plant, the first thing you should do is:
   A. Notify OSHA.
   B. Report it to your supervisor.
   C. Note it in the company safety log.
   D. Walk off the job.
   E. None of the above answers is correct.

9. OSHA regulations state that machines or equipment are safe after they are:
   A. Locked or tagged out.
   B. Turned off.
   C. Assumed de-energized.
   D. Written in the maintenance log.
   E. None of the above answers is correct.

10. Before operating machines, the operators should:
   A. Ask a co-worker.
   B. Operate them until they learn how.
   C. Read all the operating manuals.
   D. Wear gloves.
   E. None of the above answers is correct.

TLD-A1
Follow Safety Manuals and All Safety Regulations/Requirements
Self-Assessment Answer Key

1. D

2. C

3. B

4. A

5. C

6. A

7. D

8. B

9. A

10. C

TLD-A2

TOOL & DIE and EDM SERIES

MASTER Technical Module No. TLD-A2

Subject: **Tool & Die and EDM** **Time: 2 Hrs.**

Duty: **Practice Safety**
Task: Maintain Safe Equipment and Machinery

Objective(s):

Upon completion of this unit the student will be able to:
a. Wear protective safety clothing as required;
b. Maintain and use protective guards and equipment on machinery;
c. Locate and properly maintain safe equipment and machinery; and,
d. Use lifting aids when necessary.

Instructional Materials:

MASTER Handout (TLD-A2-HO)
MASTER Laboratory Exercise (TLD-A2-LE)
MASTER Laboratory Aid (TLD-A2-LA)
MASTER Self-Assessment

References:

Machine Tool Practices, Kibbe, Neely, and Meyer, Wiley Publishing, Latest Edition, Unit 1
OSHA General Industry Requirements, U. S. Government Printing Office, Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:
TLD-A1 "Follow Safety Manuals and All Safety Regulations/Requirements"

Introduction:

Safety is taught by schools and industries but it is up to the individual worker to put it into practice. Read the rules and regulations to know what clothing is safe for the job you are doing. Other manuals tell you how to safely operate and service machinery and equipment. There are also safety tips on how to lift or use lifting aids when moving or lifting is done. Being safe never takes as long as getting well.

Presentation Outline:

I. Wear Protective Safety Clothing as Required
  A. Different types of safety clothing
    1. Protective from debris, cuts, and blows
      a. Hard hat, safety glasses or goggles, work gloves when necessary
      b. Sturdy footwear
      c. Long sleeved shirt (sleeves rolled down and buttoned)
    2. Fire-retardant and fire-resistant clothing
      a. Long sleeved, 100% cotton shirt
      b. Long pants, 100% cotton
      c. Leather chest protector, sleeves
    3. Optical filters to protect vision from intense light
      a. Welding hood or goggles
      b. Safety glasses or goggles for grinding
      c. Tinted goggles for cutting torch work
    4. Breathing protection
      a. Mask for dust, lint, smoke
  B. Function and use of safety clothing
    1. Man made fiber clothing melts to worker's skin when ignited
    2. Prevents cuts and abrasions
    3. Keep shirt sleeves rolled down (hangs on equipment)
    4. Do not cuff pant legs (causes tripping)
    5. Do not wear jewelry
      a. Catches in moving parts
      b. Conducts electricity
    6. Do not wear neckties around moving parts of machinery
    7. Keep belts and apron strings tied and away from moving equipment

II. Maintain and Use Protective Guards and Equipment on Machinery
  A. Purposes of various guards
    1. Do not operate a machine until guards are in place
    2. Stop the machine to make adjustments or repairs
    3. Disconnect power before removing guards or panels
  B. Evaluation and maintenance of protective equipment
    1. Use only those electrical devices which have been approved by UL (Underwriters' Laboratories)
    2. Do not use defective equipment
    3. Report defective or unsafe equipment immediately
    4. Make sure equipment is properly grounded

III. Locate and Properly Maintain Safe Equipment and Machinery
  A. Install safety barriers

- B. Use caution signs
- C. Install lock and tag devices
- D. Know where fire extinguishers are and how to use them

IV. Use Lifting Aids When Necessary

- A. Discuss recommended limits on single-person lifting
- B. Discuss proper lifting methods (use of the legs)
  1. Use your legs (bend your knees)
  2. Keep the load close to your body
  3. Don't twist your body while lifting
  4. Make sure you can see where you are going
  5. Wear support belts
- C. Discuss team-lifting
  1. Keep load the same height while lifting
  2. Move and lift on command
  3. Use dolly, wheelbarrow, or forklift
- D. Determine lifting ratings of lifting equipment
  1. Know how your forklift operates
  2. Understand load characteristics (weight, size, shape)
- E. Determine holding ratings of static lifting devices
- F. Evaluate positions on the workpiece for placement of lifting and holding devices

Practical Application:

Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-A3) dealing with the safe operating procedures for hand and machine tools.

TLD-A2-HO
Maintain Safe Equipment and Machinery
Attachment 1: **MASTER** Handout

Objective(s):

Upon completion of this unit the student will be able to:

- a. Wear protective safety clothing as required;
- b. Maintain and use protective guards and equipment on machinery;
- c. Locate and properly maintain safe equipment and machinery; and,
- d. Use lifting aids when necessary.

Module Outline:

- I. Wear Protective Safety Clothing as Required
  - A. Different types of safety clothing
    - 1. Protective from debris, cuts, and blows
      - a. Hard hat, safety glasses or goggles, work gloves when necessary
      - b. Sturdy footwear
      - c. Long sleeved shirt (sleeves rolled down and buttoned)
    - 2. Fire-retardant and fire-resistant clothing
      - a. Long sleeved, 100% cotton shirt
      - b. Long pants, 100% cotton
      - c. Leather chest protector, sleeves
    - 3. Optical filters to protect vision from intense light
      - a. Welding hood or goggles
      - b. Safety glasses or goggles for grinding
      - c. Tinted goggles for cutting torch work
    - 4. Breathing protection
      - a. Mask for dust, lint, smoke
  - B. Function and use of safety clothing
    - 1. Man made fiber clothing melts to worker's skin when ignited
    - 2. Prevents cuts and abrasions
    - 3. Keep shirt sleeves rolled down (hangs on equipment)
    - 4. Do not cuff pant legs (causes tripping)
    - 5. Do not wear jewelry
      - a. Catches in moving parts
      - b. Conducts electricity
    - 6. Do not wear neckties around moving parts of machinery
    - 7. Keep belts and apron strings tied and away from moving equipment
- II. Maintain and Use Protective Guards and Equipment on Machinery
  - A. Purposes of various guards

        1. Do not operate a machine until guards are in place
        2. Stop the machine to make adjustments or repairs
        3. Disconnect power before removing guards or panels
    B. Evaluation and maintenance of protective equipment
        1. Use only those electrical devices which have been approved by UL (Underwriters' Laboratories)
        2. Do not use defective equipment
        3. Report defective or unsafe equipment immediately
        4. Make sure equipment is properly grounded

III. Locate and Properly Maintain Safe Equipment and Machinery
    A. Install safety barriers
    B. Use caution signs
    C. Install lock and tag devices
    D. Know where fire extinguishers are and how to use them

IV. Use Lifting Aids When Necessary
    A. Discuss recommended limits on single-person lifting
    B. Discuss proper lifting methods (use of the legs)
        1. Use your legs (bend your knees)
        2. Keep the load close to your body
        3. Don't twist your body while lifting
        4. Make sure you can see where you are going
        5. Wear support belts
    C. Discuss team-lifting
        1. Keep load the same height while lifting
        2. Move and lift on command
        3. Use dolly, wheelbarrow, or forklift
    D. Determine lifting ratings of lifting equipment
        1. Know how your forklift operates
        2. Understand load characteristics (weight, size, shape)
    E. Determine holding ratings of static lifting devices
    F. Evaluate positions on the workpiece for placement of lifting and holding devices

TLD-A2-LE
Maintain Safe Equipment and Machinery
Attachment 2: MASTER Laboratory Exercise

The instructor will display as much protective equipment, such as welding masks, breathers, and hard hats as is practical and desirable. The instructor should demonstrate the proper use of this equipment.

Due to the nature of this exercise, no answer key is possible.

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

Name__________________________ Date_______________

TLD-A2
Maintain Safe Equipment and Machinery
Self-Assessment

Circle the letter preceding the correct answer.

1. Back injuries, often from poor ________ are the most common type of serious occupational injury.
   A. Lifting techniques
   B. Muscle structure
   C. Attitude adjustment
   D. Warm-up

2. If a load is too heavy, get help or use a special:
   A. Lifting techniques.
   B. Mechanical device.
   C. Platforms.
   D. Friends.

3. When lifting or lowering from high places, stand on a:
   A. Ladder.
   B. Chair.
   C. Platform.
   D. Box.

4. Energy can be mechanical, _____________, hydraulic, or pneumatic.
   A. Powerful
   B. Electrical
   C. Inactive
   D. All of the above

5. One step in the lockout procedure is to ___________ to make sure the power is off.
   A. Test the operating controls
   B. Ask your supervisor
   C. Check with co-workers
   D. Turn switch off

6. Remember, ___________ alone don't prevent equipment from starting up.
   A. Locks
   B. Verbal instructions
   C. Tags
   D. All of the above

7. Which of the following are unsafe in the industrial workplace?
   - A. Jewelry
   - B. Man-made fiber clothing
   - C. Open-toe shoes
   - D. All of the above

8. Proper protection equipment for a welder always includes all of the following except:
   - A. Eye protection.
   - B. Ear protection.
   - C. Flame-resistant gloves.
   - D. Gas mask.

9. Ultraviolet rays are harmful when welding because they produce:
   - A. Intense heat.
   - B. Skin cancer.
   - C. Eye damage.
   - D. Metal fatigue.

10. In double insulated tools, protection against electric shock is provided by the:
    - A. Insulated case or liner.
    - B. Two-wire supply cord.
    - C. Three-wire supply cord.
    - D. Lug.

11. It is good practice to connect the neutral conductor and the metallic conduit of an electrical circuit to a common ground, because doing so:
    - A. Eliminates ground faults.
    - B. Provides more protection against shock.
    - C. Reduces fault current.
    - D. Improves the voltage in the circuit.

12. Damaged or deteriorated conductors on machinery or equipment should be:
    - A. Separated.
    - B. Replaced.
    - C. Taped.
    - D. Reported.

13. All equipment should be inspected before use.
    - A. True
    - B. False

14. Guards may be left off equipment for frequent servicing while the equipment is running.
   A. True
   B. False

15. It is permissible to loan your lock out key to co-workers.
   A. True
   B. False

TLD-A2
Maintain Safe Equipment and Machinery
Self-Assessment Answer Key

1. A
2. B
3. C
4. B
5. A
6. C
7. D
8. D
9. C
10. A
11. B
12. B
13. A
14. B
15. B

TOOL & DIE and EDM SERIES

MASTER Technical Module No. TLD-A3

Subject: **Tool & Die and EDM** **Time: 2 Hrs.**

Duty: **Practice Safety**
Task: Use Safe Operating Procedures for Hand and Machine Tools

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Objective(s):

Upon completion of this unit the student will be able to:
a. Identify and understand safe machine operating procedures; and,
b. Demonstrate safe machine operation.

Instructional Materials:

MASTER Handout (TLD-A3-HO)
MASTER Laboratory Exercise (TLD-A3-LE)
MASTER Laboratory Aid (TLD-A3-LA)
MASTER Self-Assessment
Operation manuals for all covered machines

References:

Machine Tool Practices, Kibbe, Neely, and Meyer, Wiley Publishing, Latest Edition, Unit 1
OSHA General Industry Requirements, U. S. Government Printing Office, Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:
TLD-A1 "Follow Safety Manuals and All Safety Regulations/Requirements"
TLD-A2 "Maintain Safe Equipment and Machinery"

Introduction:

The reason that there are safety guards on machines is to prevent accidents. Read the operating manuals and train for the operation of the machine before attempting to use it. You cannot always tell whether a part is moving or energized by just looking at it. Before working on the machine, always bring the machine to a zero energy state. The more you learn about the machine, the safer and easier your work will be.

Presentation Outline:

- I. Identify and Understand Safe Machine Operating Procedures
    - A. Never make adjustments on a machine while it is running
        - 1. Keep guards in place at all times
        - 2. Discontinue power before servicing
        - 3. Keep body parts clear of moving machinery
        - 4. Beware of sharp edges and flying debris
        - 5. Secure work pieces to prevent slipping
        - 6. Never stand directly in line with blades or knives
        - 7. Avoid kickback
        - 8. Feed stack into machine correctly
    - B. Electrical safety
        - 1. Use only those electrical devices which have been approved by UL (Underwriters' Laboratories)
        - 2. Stand on dry surface when working on electrical equipment
        - 3. Replace defective cords or plugs on equipment
        - 4. Use only those tools that are in good condition
        - 5. Use only carbon dioxide or dry chemical fire extinguishers for control of electrical fires
        - 6. Obtain help when working on equipment that may become energized
    - C. Avoid horseplay and practical jokes
    - D. Keep work area clean.
- II. Demonstrate Safe Machine Operation
    - A. Good housekeeping
        - 1. Materials and equipment should be stacked straight and neat
        - 2. Keep aisles and walkways clear of tools, materials, and debris
        - 3. Dispose of scraps and rubbish daily
        - 4. Clean up spills
        - 5. Clean and store hand tools
    - B. Good techniques
        - 1. Always walk - do not run
        - 2. Never talk to or interrupt anyone who is operating a machine
        - 3. Never leave tools or pieces of stock lying on table surface of a machine being used
        - 4. When finished with a machine, turn power OFF and wait until blades or cutters have come to a complete stop before leaving
        - 5. Check stock for defects before machining
            - a. Do not use a machine until you understand it thoroughly
            - b. Do not jam or rush stock into machinery
            - c. Keep guards in place
            - d. Make sure power is OFF before working on or servicing

    6. Keep hands and fingers away from moving parts
    7. Don't try to run too small a piece through the machine
    8. Use a brush to clean the surface table
    9. Keep your eyes focused on what you are working on
    10. Never use an air hose to blow debris off yourself or other workers
    11. Report faulty machinery to your supervisor
    12. Make sure machinery is properly grounded
    13. Never leave a piece of machinery that is running unattended
    14. Make sure stack is solidly supported

C. Miscellaneous materials
    1. Molten metal - can splash and cause serious burns
    2. Chemicals - burn or irritate the skin or cause eye damage
    3. Broken glass - causes cuts, can get in the eyes
    4. Pointed objects - knives, screwdrivers, punches, staples can puncture the skin
    5. Rough material - can scrape your skin and cause infections

D. Machinery
    1. Understand the safety regulations that involve the guarding of moving parts
    2. Know what parts of the equipment are energized
    3. Use all safeguards that have been provided to protect people from machinery
    4. See that all guards and protectors are in place before you start to work
    5. If you must work nearer, turn the machine off and lock out the power
    6. Never work in, around, or near dangerous, unguarded openings without wearing a safety belt and a lifeline that is properly seamed

E. One-fifth of all injuries on the job involve moving parts, machinery, or tools

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Practical Application:

The students shall identify all major safeguards and protective devices on all covered machinery.

Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-A4) dealing with maintaining a clean and safe work environment

TLD-A3-HO
Use Safe Operating Procedures for Hand and Machine Tools
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:
- a. Identify and understand safe machine operating procedures; and,
- b. Demonstrate safe machine operation.

Module Outline:

- I. Identify and Understand Safe Machine Operating Procedures
  - A. Never make adjustments on a machine while it is running
    - 1. Keep guards in place at all times
    - 2. Discontinue power before servicing
    - 3. Keep body parts clear of moving machinery
    - 4. Beware of sharp edges and flying debris
    - 5. Secure work pieces to prevent slipping
    - 6. Never stand directly in line with blades or knives
    - 7. Avoid kickback
    - 8. Feed stack into machine correctly
  - B. Electrical safety
    - 1. Use only those electrical devices which have been approved by UL (Underwriters' Laboratories)
    - 2. Stand on dry surface when working on electrical equipment
    - 3. Replace defective cords or plugs on equipment
    - 4. Use only those tools that are in good condition
    - 5. Use only carbon dioxide or dry chemical fire extinguishers for control of electrical fires
    - 6. Obtain help when working on equipment that may become energized
  - C. Avoid horseplay and practical jokes
  - D. Keep work area clean.
- II. Demonstrate Safe Machine Operation
  - A. Good housekeeping
    - 1. Materials and equipment should be stacked straight and neat
    - 2. Keep aisles and walkways clear of tools, materials, and debris
    - 3. Dispose of scraps and rubbish daily
    - 4. Clean up spills
    - 5. Clean and store hand tools
  - B. Good techniques
    - 1. Always walk - do not run
    - 2. Never talk to or interrupt anyone who is operating a machine

3. Never leave tools or pieces of stock lying on table surface of a machine being used
4. When finished with a machine, turn power OFF and wait until blades or cutters have come to a complete stop before leaving
5. Check stock for defects before machining
    a. Do not use a machine until you understand it thoroughly
    b. Do not jam or rush stock into machinery
    c. Keep guards in place
    d. Make sure power is OFF before working on or servicing
6. Keep hands and fingers away from moving parts
7. Don't try to run too small a piece through the machine
8. Use a brush to clean the surface table
9. Keep your eyes focused on what you are working on
10. Never use an air hose to blow debris off yourself or other workers
11. Report faulty machinery to your supervisor
12. Make sure machinery is properly grounded
13. Never leave a piece of machinery that is running unattended
14. Make sure stack is solidly supported

C. Miscellaneous materials
    1. Molten metal - can splash and cause serious burns
    2. Chemicals - burn or irritate the skin or cause eye damage
    3. Broken glass - causes cuts, can get in the eyes
    4. Pointed objects - knives, screwdrivers, punches, staples can puncture the skin
    5. Rough material - can scrape your skin and cause infections

D. Machinery
    1. Understand the safety regulations that involve the guarding of moving parts
    2. Know what parts of the equipment are energized
    3. Use all safeguards that have been provided to protect people from machinery
    4. See that all guards and protectors are in place before you start to work
    5. If you must work nearer, turn the machine off and lock out the power
    6. Never work in, around, or near dangerous, unguarded openings without wearing a safety belt and a lifeline that is properly seamed

E. One-fifth of all injuries on the job involve moving parts, machinery, or tools

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For this exercise, the instructor should allow the students to observe other workers at their stations. The students should look for only practices related to safety. Upon returning to class, the students and instructor should discuss what they saw.

NOTE TO ALL STUDENTS: Unless your instructor tells you otherwise, all questions are to be directed to the instructor only. Do **not** disturb you fellow workers at their stations. Such distractions, in and of themselves, pose risks!

Due to the nature of this exercise, no answer key is possible.

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and,
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

Name_____________________________ Date________________

TLD-A3
Use Safe Operating Procedures for Hand and Machine Tools
Self-Assessment

Circle the letter preceding the correct answer.

1. Barrier guards ____________ the operator's access to the danger zone.
   A. Limit
   B. Prevent
   C. Stop the operator from entering maintenance area
   D. All of the above

2. Equipment grounding is accomplished by a separate wire which is colored:
   A. White.
   B. Black.
   C. Green.
   D. Red.

3. "Intrinsically safe" equipment is designed so that it cannot:
   A. Become damaged if dropped.
   B. Ignite materials nearby.
   C. Start its built-in alarm.
   D. Eliminate ground faults.

4. When making repairs on machinery the most important rule is to:
   A. Lock-out and tag-out.
   B. Report and document.
   C. Install barricades.
   D. Notify co-workers.

5. Safety guards would not be needed on machines if:
   A. Workers would be more careful.
   B. Machines had no moving parts.
   C. Safety rules were strictly enforced.
   D. Machines were better designed.

6. When you do maintenance work you are safer if you wear:
   - A. A good-luck charm bracelet.
   - B. Loose, comfortable clothing.
   - C. Tight-fitting clothing.
   - D. A narrow necktie.

7. Which of the following is not a pinch point?
   - A. Where a belt meets a pulley
   - B. Where a chain meets a sprocket
   - C. Where a belt passes close to a fixed object
   - D. Where a drill bit meets a work piece

8. After you have locked out the power to a machine, you should:
   - A. Make sure all moving parts have stopped.
   - B. Drain the hydraulic and pneumatic lines.
   - C. Block any parts that might move.
   - D. Do all of the above.

9. Debris should be cleared from machines using your:
   - A. Bare hands.
   - B. High pressure air hose.
   - C. Brush.
   - D. Neither, leave it for the next shift.

10. Which of the following statements is correct?
    - A. Understand the safety regulations that involve the guarding of moving parts.
    - B. Knowing what parts of the equipment are energized.
    - C. Use all safeguards to protect people.
    - D. All of the above.

11. You should begin work on a machine only after:
    - A. The supervisor tells you to.
    - B. You have read operating instructions and have been properly trained.
    - C. Warned other people.
    - D. All of the above.

12. Only authorized employees are permitted to install or remove locks or tags.
    - A. True
    - B. False

13. If a machine can't be locked or tagged a guard should be stationed at the controls.
    A. True
    B. False

14. It is permissible to talk to persons operating a piece of machinery.
    A. True
    B. False

15. Feed and extracting tools make it unnecessary for the operator to reach into the danger zone.
    A. True
    B. False

TLD-A3
Use Safe Operating Procedures for Hand and Machine Tools
Self-Assessment Answer Key

1. A
2. C
3. B
4. A
5. B
6. C
7. D
8. D
9. C
10. D
11. B
12. A
13. A
14. B
15. A

TOOL & DIE and EDM SERIES

MASTER Technical Module No. TLD-A4

Subject: Tool & Die and EDM **Time: 4 Hrs.**

Duty: **Practice Safety**
Task: Maintain a Clean and Safe Work Environment

Objective(s):

Upon completion of this unit the student will be able to:
a. Keep work areas clean;
b. Clean machine/hand tools when work is completed;
c. Put tools away when work is finished;
d. Keep isles clear of equipment and materials;
e. Perform preventive maintenance as required; and,
f. Understand chemical hazards and the use of Material Safety Data Sheets (MSDS).

Instructional Materials:

MASTER Handout (TLD-A4-HO)
MASTER Laboratory Exercise (TLD-A4-LE)
MASTER Laboratory Aid (TLD-A4-LA)
MASTER Self-Assessment

References:

Machine Tool Practices, Kibbe, Neely, and Meyer, Wiley Publishing, Latest Edition, Unit 1
OSHA General Industry Requirements, U. S. Government Printing Office, Latest Edition
Materials Safety Data Sheets

Student Preparation:

Students should have previously completed the following Technical Modules:

TLD-A1	"Follow Safety Manuals and All Safety Regulations/Requirements"
TLD-A2	"Maintain Safe Equipment and Machinery"
TLD-A3	"Use Safe Operating Procedures for Hand and Machine Tools"

Introduction:

Cleanliness is the first rule of safety. A clean neat work area helps prevent accidents. A cluttered area invites slips, trips, or falls. Clean up around your machine or equipment. If you are unable to do so, ask your supervisor for a helper to clean or stack material. Clean and store tools when you are finished and keep cords and hoses rolled up. Most accidents are caused by workers who do unsafe things. Learn to do your part by helping to create a safe work environment.

Presentation Outline:

I. Keep Work Areas Clean
  A. Discuss the associated dangers of the most common hazards of the work place
    1. Tripping/falling hazards caused by spills, loose objects, etc.
      a. Wipe up spills immediately
      b. Dispose of scrap material
      c. Do not wear loose clothing
      d. Never roll sleeves or pants
      e. keep shoe strings tied
      f. Position electrical cords and air hoses in safe areas
    2. Chemical hazards
      a. Inhalants
      b. Chemical burns
      c. Flammable liquids
      d. Explosives and explosive combinations
      e. Toxins
    3. Electrical hazards
    4. High-pressure hazards
  B. Discuss methods of avoiding and correcting common hazards
II. Clean Machine/Hand Tools When Work Is Completed
III. Put Tools Away When Work Is Finished
IV. Keep Isles Clear of Equipment and Materials
V. Perform Preventive Maintenance as Required
  A. Discuss that certain machines require extra precautions
  B. Discuss how general maintenance enhances general safety
VI. Understand the Use of Material Safety Data Sheets (MSDS)
  A. What chemicals have MSDS?
  B. Where are the MSDS kept?
  C. What information is on the MSDS?
    1. Product identification
      a. Specific product name and common name
      b. Precautionary labeling
      c. Safety equipment

   d. Precautionary label statements
   e. Storage color code
2. Hazardous components
3. Physical data
   a. Boiling point
   b. Vapor pressure
   c. Melting point
   d. Vapor density
   e. Specific gravity
   f. Evaporation rate
   g. Solubility in water
   h. Percentage of volatile components by volume
   I. Appearance & odor
4. Fire and explosion hazard data
   a. Flash point
   b. NFPA 704M rating
   c. Flammable limits (upper and lower)
   d. Fire extinguishing media
   e. Special fire-fighting procedures
   f. Toxic gases produced
5. Health hazard data
   a. Threshold limit value
   b. Permissible exposure limit
   c. Toxicity
   d. Carcinogenicity
   e. Effects of over-exposure
   f. Target organs (those most affected by exposure)
   g. Medical conditions aggravated by exposure
   h. Routes of entry
   I. Emergency and first-aid procedures
6. Reactivity data
   a. Stability
   b. Hazardous polymerization
   c. Conditions to avoid
   d. Incompatible materials
   e. Decomposition products
7. Spill and disposal procedures
   a. Procedures: spill or discharge
   b. Procedures: disposal
   c. EPA hazardous waste number
8. Protective equipment
   a. Ventilation
   b. Respiratory protection
   c. Eye/skin protection
9. Storage and handling precautions

        - a. Storage color code
        - b. Special precautions
    - 10. Transportation data and additional information
        - a. Domestic transport
            - 1) DOT shipping name
            - 2) Hazard class
            - 3) UN/NA
            - 4) Labels
            - 5) Reportable quantity
        - b. International
            - 1) IMO shipping name
            - 2) Hazard class
            - 3) UN/NA
            - 4) Labels

Practical Application:

Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-A5) dealing with using safe material handling practices.

TLD-A4-HO
Maintain a Clean and Safe Work Environment
Attachment 1: **MASTER** Handout

Objective(s):

Upon completion of this unit the student will be able to:

- a. Keep work areas clean;
- b. Clean machine/hand tools when work is completed;
- c. Put tools away when work is finished;
- d. Keep isles clear of equipment and materials;
- e. Perform preventive maintenance as required; and,
- f. Understand chemical hazards and the use of Material Safety Data Sheets (MSDS).

Module Outline:

- I. Keep Work Areas Clean
  - A. Discuss the associated dangers of the most common hazards of the work place
    - 1. Tripping/falling hazards caused by spills, loose objects, etc.
      - a. Wipe up spills immediately
      - b. Dispose of scrap material
      - c. Do not wear loose clothing
      - d. Never roll sleeves or pants
      - e. keep shoe strings tied
      - f. Position electrical cords and air hoses in safe areas
    - 2. Chemical hazards
      - a. Inhalants
      - b. Chemical burns
      - c. Flammable liquids
      - d. Explosives and explosive combinations
      - e. Toxins
    - 3. Electrical hazards
    - 4. High-pressure hazards
  - B. Discuss methods of avoiding and correcting common hazards
- II. Clean Machine/Hand Tools When Work Is Completed
- III. Put Tools Away When Work Is Finished
- IV. Keep Isles Clear of Equipment and Materials
- V. Perform Preventive Maintenance as Required
  - A. Discuss that certain machines require extra precautions
  - B. Discuss how general maintenance enhances general safety
- VI. Understand the Use of Material Safety Data Sheets (MSDS)
  - A. What chemicals have MSDS?

B. Where are the MSDS kept?
C. What information is on the MSDS?
  1. Product identification
    a. Specific product name and common name
    b. Precautionary labeling
    c. Safety equipment
    d. Precautionary label statements
    e. Storage color code
  2. Hazardous components
  3. Physical data
    a. Boiling point
    b. Vapor pressure
    c. Melting point
    d. Vapor density
    e. Specific gravity
    f. Evaporation rate
    g. Solubility in water
    h. Percentage of volatile components by volume
    I. Appearance & odor
  4. Fire and explosion hazard data
    a. Flash point
    b. NFPA 704M rating
    c. Flammable limits (upper and lower)
    d. Fire extinguishing media
    e. Special fire-fighting procedures
    f. Toxic gases produced
  5. Health hazard data
    a. Threshold limit value
    b. Permissible exposure limit
    c. Toxicity
    d. Carcinogenicity
    e. Effects of over-exposure
    f. Target organs (those most affected by exposure)
    g. Medical conditions aggravated by exposure
    h. Routes of entry
    I. Emergency and first-aid procedures
  6. Reactivity data
    a. Stability
    b. Hazardous polymerization
    c. Conditions to avoid
    d. Incompatible materials
    e. Decomposition products
  7. Spill and disposal procedures
    a. Procedures: spill or discharge
    b. Procedures: disposal

        - c. EPA hazardous waste number
- 8. Protective equipment
    - a. Ventilation
    - b. Respiratory protection
    - c. Eye/skin protection
- 9. Storage and handling precautions
    - a. Storage color code
    - b. Special precautions
- 10. Transportation data and additional information
    - a. Domestic transport
        - 1) DOT shipping name
        - 2) Hazard class
        - 3) UN/NA
        - 4) Labels
        - 5) Reportable quantity
    - b. International
        - 1) IMO shipping name
        - 2) Hazard class
        - 3) UN/NA
        - 4) Labels

TLD-A4-LE
Maintain a Clean and Safe Work Environment
Attachment 2: MASTER Laboratory Exercise

The instructor will guide all students through part of the facility. Each student should write down as many safety hazards as are found. While this may appear to be an exact duplicate of TLD-A1, the purpose of this exercise is to determine how much more aware of safety and hazards the students have become.

Upon returning to class, the students and the instructor should discuss what the students observed on this tour. Each student should compare his answers to those from TLD-A1, noting any differences and the reasons for those differences.

Due to the nature of this laboratory exercise, no answer key is possible.

Safety Hazards

Type	Location	Description	Recommendations

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and,
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

Name________________________ Date_______________

TLD-A4
Maintain a Clean and Safe Work Environment
Self-Assessment:

Circle the letter preceding the correct answer.

1. A chemical label tells:
   A. The carrier where to send the container
   B. Only what the manufacture wants you to know
   C. Only the maximum hazard
   D. What a chemical's identity is

2. Labels are an important part of:
   A. Your company's Hazard Communication Program
   B. Right to know
   C. Both a and b
   D. Neither a nor b

3. On some labels, ___ represent the kind of hazards and ___ represent the degree of hazard.
   A. Colors . . . numbers
   B. Caution . . . danger
   C. OSHA . . . MDS
   D. All of the above

4. Before you start any jobs with chemicals, check the detailed hazard and safety information on the:
   A. Supervisor's desk
   B. Material Safety Data Sheet
   C. Dock
   D. Poison control center

5. Chemicals can enter the body by:
   A. Swallowing
   B. Inhaling
   C. Skin contact
   D. All of the above

6. The Control Measures Section of the MSDS covers the:
   A. Protective equipment you might need
   B. Exposure limits
   C. Temperature limits
   D. Spill and leak

7. Which of the following is *not* a good housekeeping rule?
   A. Always put tools in their proper place
   B. Dispose of waste material properly
   C. Sweep debris from machine with hands
   D. Wipe up spills immediately

8. Which of the following is a fire risk?
   A. Disposing of oily rags in tightly covered containers
   B. Storing flammables in electrical closets
   C. Keeping motors and machines free of dust and grease
   D. Keeping passages and fire exits clear

9. Before performing maintenance on a machine you should:
   A. Shut off power
   B. Warn other people
   C. Bring the machine to a zero energy state
   D. Lock-out power and the valves

10. If you have to work on a suspended load you should:
    A. Make sure you have clearance
    B. Place barricades around the hoist
    C. Watch out for pedestrians
    D. Set the load down first

11. Flammable liquids should be stored in:
    A. Open metal containers
    B. Sealed metal containers
    C. Open glass containers
    D. Sealed glass containers

12. During maintenance, the controls of a power-driven conveyor should be locked in the OFF position to prevent:
    A. Start-up
    B. Theft
    C. Damage
    D. Fire

13. When working aloft, you need:
    A. Guard rail clamps
    B. Safety toed shoes
    C. A safety harness
    D. A helper posted below

14. Scrap material should be:
    A. Stacked around the machine
    B. Cleared from the area
    C. Swept out in aisles
    D. All of the above

15. Danger that is part of the job is a:
    A. Built-in hazard
    B. Walk-on hazard
    C. Accident chain
    D. Hazardous duty
    E. Problem for the insurance company, not me

TLD-A4
Maintain a Clean and Safe Work Environment
Self-Assessment Answer Key

1. D

2. C

3. A

4. B

5. D

6. A

7. C

8. B

9. C

10. D

11. B

12. A

13. C

14. B

15. A

TOOL & DIE and EDM SERIES

MASTER Technical Module No. TLD-A5

Subject: **Tool & Die and EDM** **Time: 3 Hrs.**

Duty: **Practice Safety**
Task: Use Safe Material Handling Practices

Objective(s):

Upon completion of this module the student will be able to:
a. Identify the consequences of improper lifting techniques;
b. Recognize when it is unsafe to lift an object alone;
c. Demonstrate proper lifting techniques; and,
d. Identify safety concerns to be addressed when lifting rough, sharp or fragile items.

Instructional Materials:

1. Large Empty Cardboard Box
2. Pencil
3. Paper
4. Gloves
5. Safety Glasses
6. Hand Truck
7. Conveyor
8. Chains
9. Sling
10. Face Shield
11. Side Shield
12. **MASTER** Handout (TLD-A5-HO)
13. **MASTER** Laboratory Exercise (TLD-A5-LE)
14. **MASTER** Laboratory Aid (TLD-A5-LA)
15. Copy of 29 CFR 1910 Regulations

References:

First Aid Textbook, American National Red Cross, 17th and D Sts. NW., Washington DC 20006, Latest Edition

Approval Guide; Handbook of Property Conservation; and *Loss Prevention Data,* Factory Mutual Engineering Corporation of the Factory

Mutual System, 1151 Boston -Providence Turnpike, Norwood, MA 02062, Latest Editions

Guide to Occupational Safety and Health Management, Firenze, Robert J., Dubuque, IA, Kendall/Hunt Publishing Co., Latest Edition

Supervisor's Guide to Human Relations, Hannaford, Earle S., Chicago, IL, National Safety Council, Latest Edition

IES Lighting Handbook (The Standard Lighting Guide); and *Practice for Industrial Lighting (ANSI A11.1-1965),* Laminating Engineering Society, 345 East 47th St., New York, NY 10017, Latest Editions

Encyclopedia of Occupational Health and Safety; and *Loss Control,* International Labor Organization, 666 11th St. NW., Washington, DC, 20001, Latest Edition

A Safety Guidebook for Trades and Services, Van Nostrand Reinhold Co., New York, NY, Latest Edition

Fire Prevention Handbook; Fire Protection Guide on Hazardous Materials; Inspection Manual; National Electrical Code, Std. No. 70 (ANSI CI-1971); National Fire Codes (10 Volumes); and *Standards and Recommended Practices,* National Fire Protection Association, 470 Atlantic Ave., Boston, MA 02210, Latest Editions

Maintaining a Healthy Back, - 15m - Video Tape - Ergodyne Corp., Latest Edition

Lifting, Eye Protection and Hand Tool Safety, - 20m - Video Tape - BBP, Latest Edition

Rigging, - Video Tape - ITS - Video Tape, Latest Edition

Basic Injury Prevention, - C.L.M. - Video Tape, Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:

TLD-A1	"Follow Safety Manuals and All Safety Regulations/Requirements"
TLD-A2	"Maintain Safe Equipment and Machinery"
TLD-A3	"Use Safe Operating Procedures for Hand and Machine Tools"
TLD-A4	"Maintain a Clean and Safe Work Environment"

Introduction:

Injuries resulting from improper lifting probably are the number one cause of employee injury. A strong physically fit body is not enough to ensure you won't have back problems. Following time proven lifting methods and getting help when you need it is your best assurance. Remember you are responsible for your own safety.

Presentation Outline:

I. Discuss the Importance of Lifting Safely
  A. Give each student a copy of the following attachments:
    1. Laboratory aid
    2. Objectives, reading assignments, and module outline
    3. Laboratory worksheet
II. Identify the Steps to Manually Lift Safely
  A. Estimate the load to be lifted. If it is heavier than one person should attempt, get help.
  B. Place feet properly. Spread your feet slightly (comfortably), with one foot slightly ahead of the other and alongside the object.
  C. Bend knees, kneel, or squat. Get close enough to the load to reach under it without bending the back.
  D. Use blocking under objects to get a handhold and to prevent crushed fingers.
  E. Get a good grip. Be sure you can maintain your grip on the object. Use gloves when handling sharp or rough objects.
  F. Let the legs do the lifting. To rise, straighten your legs, letting the powerful leg, arm, and shoulder muscles do the lifting.
  G. Do not turn the body at the waist while carrying a load.
  H. Lower the load to the floor from the carrying position by bending the knees while keeping the back straight. This keeps the load on the leg and arm muscles. Keep fingers and toes clear as the load is set.
III. Discuss Handling Specific Shapes
  A. Locate center of gravity and use this area to lift
  B. Place as much weight as possible as close to lifting mechanism
  C. Place flat weight on button
IV. Discuss Equipment for Material Handling
  A. Hand Trucks
  B. Powered Trucks
  C. Conveyers
V. Discuss and Demonstrate Safe Use of Hand Trucks
  A. Place most of the weight on bed of hand truck
  B. May require two people if one object is difficult to lift on side
  C. Hold object tightly as handle is pulled back
  D. Adjust handle position so more weight is on hand end

  - E. After movement, hold object tightly as handle is moved upward
  - F. Lift object on one side so bed of truck can be moved away from object
- VI. Discuss and Demonstrate Use of Powered Hand Trucks
  - A. Watch out for people
  - B. Drive unit slowly
  - C. Use manual lifting rules
- VII. Discuss and Demonstrate Safe Use of Conveyers
  - A. Watch for pinch points
  - B. Exercise caution when loading and unloading objects
  - C. Do not overload conveyers. Rollers may not move freely
- VIII. Discuss and Demonstrate Safe Use of Chains and Slings
  - A. Storage area should be clean and dry
  - B. Watch for pinch points
  - C. Inspect for defects before using:
    - 1. Chains
      - a. Wear
      - b. Stretch
      - c. Distortion
      - d. Nicks
      - e. Cracks
      - f. Gauges
    - 2. Slings
      - a. Wear
      - b. Stretch
      - c. Distortion
      - d. Flat, Sling Spots
  - D. Types
    - 1. Slings
      - a. Choker
      - b. Double Choker
      - c. Bridle
      - d. Basket
      - e. Double Basket
- IX. Discuss and Demonstrate Safe Use of Chains and Slings

Practical Application:

Students will practice correct lifting techniques. Each student will then complete the Laboratory exercise where he will be graded on demonstrating proper lifting techniques.

Evaluation and Verification:

Successful completion of this Technical Module will be based on the student's successful completion of the practical evaluation.

Summary:

Review the main lesson points using the Handout (TLD-A5-HO) as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-A6) dealing with consulting and applying MSDS for hazards of various materials.

TLD-A5-HO
Use Safe Material Handling Practices
Attachment 1: MASTER Handout

Standards of Performance:

Student shall demonstrate safety work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Identify the consequences of improper lifting techniques;
b. Recognize when it is unsafe to lift an object alone;
c. Demonstrate proper lifting techniques; and,
d. Identify safety concerns to be addressed when lifting rough, sharp or fragile items.

Module Outline:

I. Discuss the Importance of Lifting Safely
  A. Give each student a copy of the following attachments:
    1. Laboratory aid
    2. Objectives, reading assignments, and module outline
    3. Laboratory worksheet
II. Identify the Steps to Manually Lift Safely
  A. Estimate the load to be lifted. If it is heavier than one person should attempt, get help.
  B. Place feet properly. Spread your feet slightly (comfortably), with one foot slightly ahead of the other and alongside the object.
  C. Bend knees, kneel, or squat. Get close enough to the load to reach under it without bending the back.
  D. Use blocking under objects to get a handhold and to prevent crushed fingers.
  E. Get a good grip. Be sure you can maintain your grip on the object. Use gloves when handling sharp or rough objects.

    - F. Let the legs do the lifting. To rise, straighten your legs, letting the powerful leg, arm, and shoulder muscles do the lifting.
    - G. Do not turn the body at the waist while carrying a load.
    - H. Lower the load to the floor from the carrying position by bending the knees while keeping the back straight. This keeps the load on the leg and arm muscles. Keep fingers and toes clear as the load is set.
- III. Discuss Handling Specific Shapes
    - A. Locate center of gravity and use this area to lift
    - B. Place as much weight as possible as close to lifting mechanism
    - C. Place flat weight on button
- IV. Discuss Equipment for Material Handling
    - A. Hand Trucks
    - B. Powered Trucks
    - C. Conveyers
- V. Discuss and Demonstrate Safe Use of Hand Trucks
    - A. Place most of the weight on bed of hand truck
    - B. May require two people if one object is difficult to lift on side
    - C. Hold object tightly as handle is pulled back
    - D. Adjust handle position so more weight is on hand end
    - E. After movement, hold object tightly as handle is moved upward
    - F. Lift object on one side so bed of truck can be moved away from object
- VI. Discuss and Demonstrate Use of Powered Hand Trucks
    - A. Watch out for people
    - B. Drive unit slowly
    - C. Use manual lifting rules
- VII. Discuss and Demonstrate Safe Use of Conveyers
    - A. Watch for pinch points
    - B. Exercise caution when loading and unloading objects
    - C. Do not overload conveyers. Rollers may not move freely
- VIII. Discuss and Demonstrate Safe Use of Chains and Slings
    - A. Storage area should be clean and dry
    - B. Watch for pinch points
    - C. Inspect for defects before using:
        1. Chains
            - a. Wear
            - b. Stretch
            - c. Distortion
            - d. Nicks
            - e. Cracks
            - f. Gauges
        2. Slings
            - a. Wear
            - b. Stretch
            - c. Distortion
            - d. Flat, Sling Spots

- D. Types
    - 1. Slings
        - a. Choker
        - b. Double Choker
        - c. Bridle
        - d. Basket
        - e. Double Basket

IX. Discuss and Demonstrate Safe Use of Chains and Slings

EXERCISE

1. Established standards for safety and conduct shall be followed.
2. Equipment required:
   Hand truck
   Conveyor
   Chains
   Sling
   Face shield
   Side shields
3. Exercises below must be taken in sequence. Instructor must confirm proficiency prior to student's progressing to next exercise.
   a. Practice manual lifting.
   b. Practice using hand truck to carry objects.
   c. Practice using powered truck to carry objects.
   d. Practice handling specific shapes.
   e. Practice lifting with slings.
   f. Practice lifting with chains.
4. Instructor will guide each exercise.
5. Instructor will grade each exercise.

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and,
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

TOOL & DIE and EDM SERIES

MASTER Technical Module No. TLD-A6

Subject: **Tool & Die and EDM** **Time: 8 Hrs.**

Duty: **Practice Safety**
Task: Consult and Apply MSDS for Hazards of Various Materials

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Objective(s):

Upon completion of this unit the student will be able to:

a. Define hazardous material;
b. Identify hazardous material;
c. Know the physical and chemical characteristics;
d. Describe storage, transportation, disposal of hazardous waste; and,
e. Explain material safety data sheets.

Instructional Materials:

MASTER Handout (TLD-A6-HO)
MASTER Laboratory Aid (TLD-A6-LA)
MASTER Self-Assessment

References:

OSHA General Industry Requirements, U. S. Government Printing Office, Latest Edition
Materials Safety Data Sheets for various chemicals

Student Preparation:

Students should have previously completed the following Technical Modules:

TLD-A1	"Follow Safety Manuals and All Safety Regulations/Requirements"
TLD-A2	"Maintain Safe Equipment and Machinery"
TLD-A3	"Use Safe Operating Procedures for Hand and Machine Tools"
TLD-A4	"Maintain a Clean and Safe Work Environment"
TLD-A5	"Use Safe Material Handling Practices"

Introduction:

Hazardous materials can cause immediate or long-term health problems if not managed properly. It is the responsibility of all persons involved with hazard waste to know the rules, the material, and how to handle the material properly.

Presentation Outline:

I. Define Hazardous Materials According to the EPA
  A. What makes a material hazardous?
    1. It is hazardous if it causes harm to people or environment
II. Identify Hazardous Materials
  A. Material Safety Data Sheets (MSDS)
    1. Companies that make and distribute hazardous substances must provide your company with a MSDS on hazardous material
    2. MSDS developed by OSHA
    3. MSDS is part of the Hazard Communication Standard or Righ to Know regulation
    4. MSDS is an easy reference for information on hazardous substances
  B. Information in MSDS
    1. What it is
    2. Who makes or sells it
    3. Where they are located
    4. Why it is hazardous
    5. How you can be exposed to the hazard
    6. Conditions that could increase the hazard
    7. How to handle the substance safely
    8. Protection to use while working with it
    9. What to do if exposed
    10. What to do if there is a spill or emergency
III. Know the Chemical and Physical Characteristics
  A. Corrosive
    1. Burns skin or eyes on contact
  B. Explosive
  C. Flammable
    1. Catches fire easily
  D. Radioactive
  E. Reactive
    1. Burns, explodes
    2. Releases toxic vapors
  F. Toxic
    1. Causes illness or possibly death

IV. Describe Storage, Transportation, Disposal
   A. Resource Conservation and Recovery Act (RCRA)
      1. Designed to reduce hazards of waste by tracking and regulating the substance
      2. Method used is called from cradle (creation) to grave (disposal)
      3. Tells what hazards are and how to keep track of them
      4. Sets up rules for handling wastes
      5. Provides strict documentation system to track them
   B. Your employer may have to report to the Environmental Protection Agency (EPA) on how the company is meeting the RCRA responsibilities
   C. The law requires companies that treat, store, or dispose of hazardous wastes to:
      1. Must have a permit
      2. Identify and analyze new hazardous waste
      3. Provide a secure facility that keeps unauthorized people out
      4. Inspect the facility regularly
      5. Have a contingency plan for fire, explosion, and spills
      6. Practice emergency response for fire, explosion, spills
      7. Provide proper protective clothing and equipment
      8. Maintain EPA-required records

Practical Application:

Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-B1) dealing with performing basic arithmetic functions.

TLD-A6-HO
Consult and Apply MSDS for Hazards of Various Materials
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Define hazardous material;
b. Identify hazardous material;
c. Know the physical and chemical characteristics;
d. Describe storage, transportation, disposal of hazardous waste; and,
e. Explain material safety data sheets.

Module Outline:

I. Define Hazardous Materials According to the EPA
  A. What makes a material hazardous?
    1. It is hazardous if it causes harm to people or environment
II. Identify Hazardous Materials
  A. Material Safety Data Sheets (MSDS)
    1. Companies that make and distribute hazardous substances must provide your company with a MSDS on hazardous material
    2. MSDS developed by OSHA
    3. MSDS is part of the Hazard Communication Standard or Right to Know regulation
    4. MSDS is an easy reference for information on hazardous substances
  B. Information in MSDS
    1. What it is
    2. Who makes or sells it
    3. Where they are located
    4. Why it is hazardous
    5. How you can be exposed to the hazard
    6. Conditions that could increase the hazard
    7. How to handle the substance safely
    8. Protection to use while working with it
    9. What to do if exposed
    10. What to do if there is a spill or emergency
III. Know the Chemical and Physical Characteristics
  A. Corrosive
    1. Burns skin or eyes on contact
  B. Explosive
  C. Flammable

   1. Catches fire easily

D. Radioactive

E. Reactive
   1. Burns, explodes
   2. Releases toxic vapors

F. Toxic
   1. Causes illness or possibly death

IV. Describe Storage, Transportation, Disposal

A. Resource Conservation and Recovery Act (RCRA)
   1. Designed to reduce hazards of waste by tracking and regulating the substance
   2. Method used is called from cradle (creation) to grave (disposal)
   3. Tells what hazards are and how to keep track of them
   4. Sets up rules for handling wastes
   5. Provides strict documentation system to track them

B. Your employer may have to report to the Environmental Protection Agency (EPA) on how the company is meeting the RCRA responsibilities

C. The law requires companies that treat, store, or dispose of hazardous wastes to:
   1. Must have a permit
   2. Identify and analyze new hazardous waste
   3. Provide a secure facility that keeps unauthorized people out
   4. Inspect the facility regularly
   5. Have a contingency plan for fire, explosion, and spills
   6. Practice emergency response for fire, explosion, spills
   7. Provide proper protective clothing and equipment
   8. Maintain EPA-required records

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and,
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

Name________________________ Date______________

TLD-A6
Consult and Apply MSDS for Hazards of Various Materials
Self-Assessment

Circle the letter preceding the correct answer.

1. The law requires companies that treat, store, or dispose of hazardous wastes to _________.
   a. Have a permit
   b. Give notice before dumping
   c. Have OSHA personnel on site at all times
   d. All of the above

2. Your employer may have to report to the ________ on how the company is meeting the RCRA responsibility.
   a. OSHA
   b. EPA
   c. RCRA
   d. Local authorities

3. The EPA requires paperwork that tracks hazardous waste from ________ to ___________.
   a. Company to company
   b. State to state
   c. Cradle to grave
   d. Manufacturer to company

4. The key pieces of information in the manifest are ___________.
   a. Manifest document number
   b. Name, address, phone numbers, EPA ID number of generator
   c. Description of the hazardous waste
   d. All of the above

5. Who must sign the manifest and keep a copy?
   a. Only the manufacture
   b. Only the shipper
   c. Only those who dispose of the waste
   d. Everyone who handles the waste

6. A material safety data sheet tells you the chemical's _________.
   a. Market value
   b. Color
   c. Physical and chemical characteristics
   d. All of the above

7. If properly wrapped, hazardous waste ___________________.
   a. May be disposed of at public dumps
   b. Must be disposed of according to the EPA guidelines
   c. Dumped on private property
   d. All of the above

8. MSDS stands for ____________.
   a. Material safety data sheet
   b. Military secret dumping site
   c. Mine safety division storage
   d. Material safe disposal site

9. OSHA developed the MSDS as part of ____________.
   a. Hazard communication standard
   b. Right-to-know regulations
   c. Both A & B
   d. Neither A nor B

10. The ____________ part of the label can either indicate a specific hazard or what personal protective equipment should be used.
    a. White
    b. Red
    c. Triangle
    d. Cross-hairs

TLD-A6
Consult and Apply MSDS for Hazards of Various Materials
Self-Assessment Answer Key

1. a

2. b

3. c

4. d

5. d

6. c

7. b

8. a

9. c

10. a

TOOL AND DIE MAKER .... skilled workers who produce tools, dies, and special guiding and holding devices that are used in machining.

	Duties	Tasks												
A	Practice Safety	A-1 Follow safety manuals and all safety regulations/ requirements	A-2 Maintain safe equipment and machinery	A-3 Use safe operating procedures for hand and machine tools	A-4 Maintain a clean and safe work environment	A-5 Use safe material handling practices	A-6 Consult and apply MSDS for hazards of various materials							
B	Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Perform basic algebraic operations	B-3 Use basic geometric principles	B-4 Perform basic trigonometric functions	B-5 Use and apply Cartesian Coordinate System								
C	Interpret Engineering Drawings and Related Documents	C-1 Interpret and understand basic layout/types of drawings	C-2 Interpret, review, and apply blueprint notes, dimensions, and tolerances	C-3 Use and apply Geometric Dimensioning and Tolerancing (GD&T)	C-4 Demonstrate traditional mechanical drafting and sketching techniques	C-5 Understand and use quality systems								
D	Demonstrate Knowledge of Manufacturing Materials	D-1 Identify materials with desired properties	D-2 Identify materials and processes to produce a part	D-3 Discuss classification systems for metal										
E	Measure/ Inspect	E-1 Understand metrology terms	E-2 Select measurement tools	E-3 Measure with hand held instruments	E-4 Eliminate measurement variables	E-5 Measure/inspect using surface plate and accessories	E-6 Inspect using stationary equipment							
F	Demonstrate Knowledge of Manufacturing Processes	F-1 Discuss metal cutting and metal cutting tools	F-2 Operate metal saws	F-3 Operate drill presses and tooling	F-4 Operate engine and turret lathes and tooling	F-5 Operate vertical and horizontal mills and tooling	F-6 Operate precision grinders	F-7 Operate heat treating equipment and processes	F-8 Operate sheet metal equipment	F-9 Operate welding equipment and processes	F-10 Estimate time required/ cost to produce a part			
G	Use Computers	G-1 Use computer operating systems	G-2 Understand computer terminology	G-3 Use file management systems	G-4 Install and use software packages									
H	Perform CAD/ CAM and CNC Programming Tasks	H-1 Discuss fundamentals of CNC machines and controls	H-2 Program and operate CNC milling machine and machining center	H-3 Program and operate CNC lathe	H-4 Use Computer-Aided Drafting (CAD) system	H-5 Create 3-D solid models	H-6 Use Computer-Aided Manufacturing (CAM) system							
I	Perform Tool and Die Making Operations	I-1 Discuss basic types and functions of jigs and fixtures	I-2 Utilize concepts of jig and fixture design	I-3 Demonstrate understanding of different types of industrial dies	I-4 Utilize basic die theory	I-5 Utilize principles of die design	I-6 Perform tool and die repair	I-7 Demonstrate tool and die making skills						
J	Operate Electrical Discharge Machine (EDM)	J-1 Discuss fundamentals of EDM	J-2 Setup and operate conventional sinker EDM	J-3 Program, setup, and operate CNC sinker EDM and EDM drill	J-4 Program, setup, and operate CNC wire EDM									

TLD PMF

TOOL & DIE and EDM SERIES

MASTER Technical Module No. TLD-B1

Subject: **Tool & Die and EDM** **Time: 1 Hr.**

Duty: **Apply Mathematical Concepts**
Task: Perform Basic Arithmetic Functions

Objective(s):

Upon completion of this unit the student will be able to:
a. Add, subtract, multiply, and divide whole numbers;
b. Add, subtract, multiply, and divide fractions; and,
c. Add, subtract, multiply, and divide decimals.

Instructional Materials:

MASTER Handout (TLD-B1-HO)
MASTER Laboratory Aid (TLD-B1-LA)
MASTER Self-Assessment

References:

Student's Shop Reference Handbook, Industrial Press, Latest Edition, Unit on Mathematics
Mathematics for Machine Technology, R. D. Smith, Delmar Publishers, Inc., Latest Edition, Units 1-12

Student Preparation:

Introduction:

Mathematics is called the "Queen of Sciences" for a definite reason. In the modern world, almost nothing can be done without it. Fundamental to success in all mathematics is a thorough and complete understanding of the four basic functions of arithmetic: Addition, Subtraction, Multiplication, and Division. Technicians must perform all functions of arithmetic on a daily basis and with complete confidence. This lesson is designed to dust off all your old memories and to permit you to see that solid base of arithmetic which you must surely have to progress.

Presentation Outline:

I. Add, Subtract, Multiply, and Divide Whole Numbers
  A. Addition of whole numbers
  B. Subtraction of whole numbers
  C. Multiplication of whole numbers
  D. Division of whole numbers
  E. Hierarchy of operations
II. Add, Subtract, Multiply, and Divide Fractions
  A. Common operations
    1. Least common denominator
    2. Factoring for reduction
    3. Improper fractions
    4. Mixed numbers
  B. Addition
  C. Subtraction
  D. Multiplication
  E. Division
III. Add, Subtract, Multiply, and Divide Decimals
  A. Aligning the decimal (addition and subtraction)
  B. Moving the decimal
    1. In division, move the decimal to the right until it is eliminated in the divisor. Move the decimal the same number of places to the right in the dividend.
    2. In multiplication, count the total number of decimals places in the two numbers being multiplied. Beginning in the product at the *right-most digit,* count off the same number of places and place the decimal.

Practical Application:

The students shall demonstrate a working knowledge of the four basic operations of arithmetic and an ability to reduce fractions.

Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-B2) dealing with performing basic algebraic operations.

TLD-B1-HO
Perform Basic Arithmetic Functions
Attachment 1: **MASTER** Handout

Objective(s):

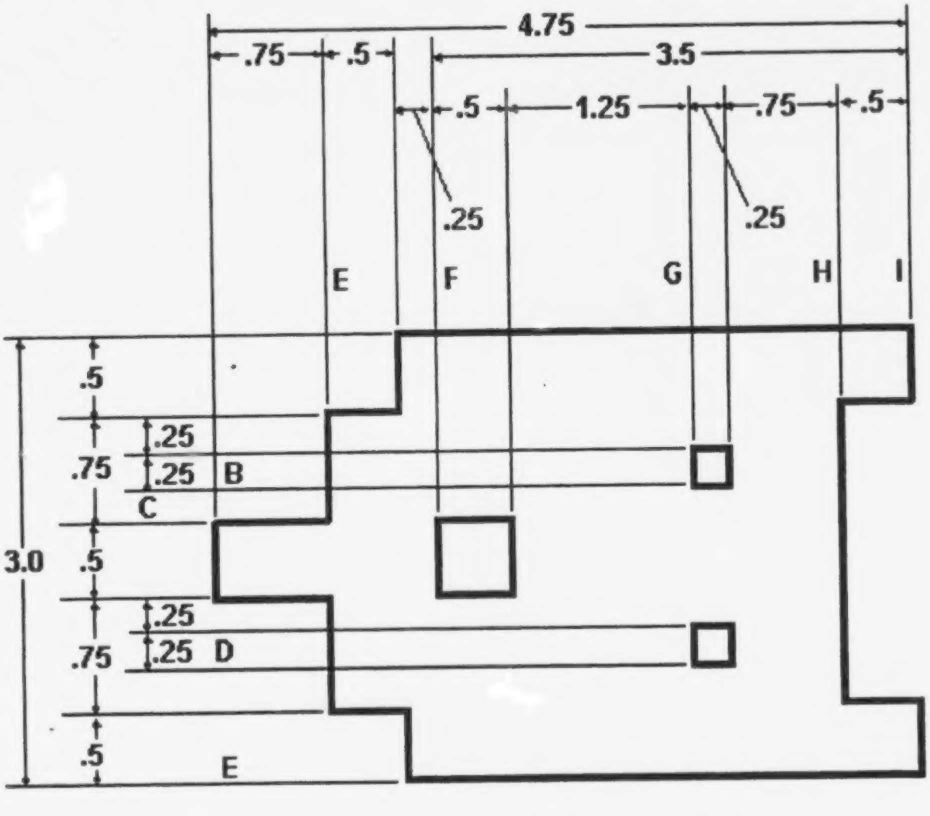
Upon completion of this unit the student will be able to:

- a. Add, subtract, multiply, and divide whole numbers;
- b. Add, subtract, multiply, and divide fractions; and,
- c. Add, subtract, multiply, and divide decimals.

Module Outline:

- I. Add, Subtract, Multiply, and Divide Whole Numbers
  - A. Addition of whole numbers
  - B. Subtraction of whole numbers
  - C. Multiplication of whole numbers
  - D. Division of whole numbers
  - E. Hierarchy of operations
- II. Add, Subtract, Multiply, and Divide Fractions
  - A. Common operations
    - 1. Least common denominator
    - 2. Factoring for reduction
    - 3. Improper fractions
    - 4. Mixed numbers
  - B. Addition
  - C. Subtraction
  - D. Multiplication
  - E. Division
- III. Add, Subtract, Multiply, and Divide Decimals
  - A. Aligning the decimal (addition and subtraction)
  - B. Moving the decimal
    - 1. In division, move the decimal to the right until it is eliminated in the divisor. Move the decimal the same number of places to the right in the dividend.
    - 2. In multiplication, count the total number of decimals places in the two numbers being multiplied. Beginning in the product at the *right-most digit,* count off the same number of places and place the decimal.

TLD-B1-LA
Perform Basic Arithmetic Functions
Attachment 2: **MASTER** Laboratory Aid


4.75
.75
.5
3.5
.5
1.25
.75
.5
.25
.25
E
F
G
H
I
3.0
.5
.75
.25
.25
B
C
.5
.75
.25
.25
D
.5
E

Name____________________________ Date________________

TLD-B1
Perform Basic Arithmetic Functions
Self-Assessment

Show all work.

Reduce the following fractions:

1. 4/64 ____________________
2. 6/4 ____________________
3. 6/16 ____________________
4. 12/32 ____________________
5. 9/16 ____________________

Perform the indicated operations:

6. 3.25 + 2.375 = ____________________
7. 15/32 + 1/4 = ____________________
8. 15/32 - 1/4 = ____________________
9. 9/64 + 9/32 = ____________________
10. 1/4 x 3/4 = ____________________
11. 1/4 ÷ 3/4 = ____________________
12. 0.625 x 1/4 = ____________________
13. 0.625 + 1.125 = ____________________
14. 1.125 - 0.75 = ____________________
15. 1.25/1.5 = ____________________

For Questions 16 through 25, use the dimensional notations on the drawing.

16. What is the distance between Line A and Line B? ____________________

17. What is the distance between Line B and Line C? ____________________

18. What is the distance between Line B and Line D? ____________________

19. What is the distance between Line C and Line E? ____________________

20. What is the distance between Line C and Line D? ____________________

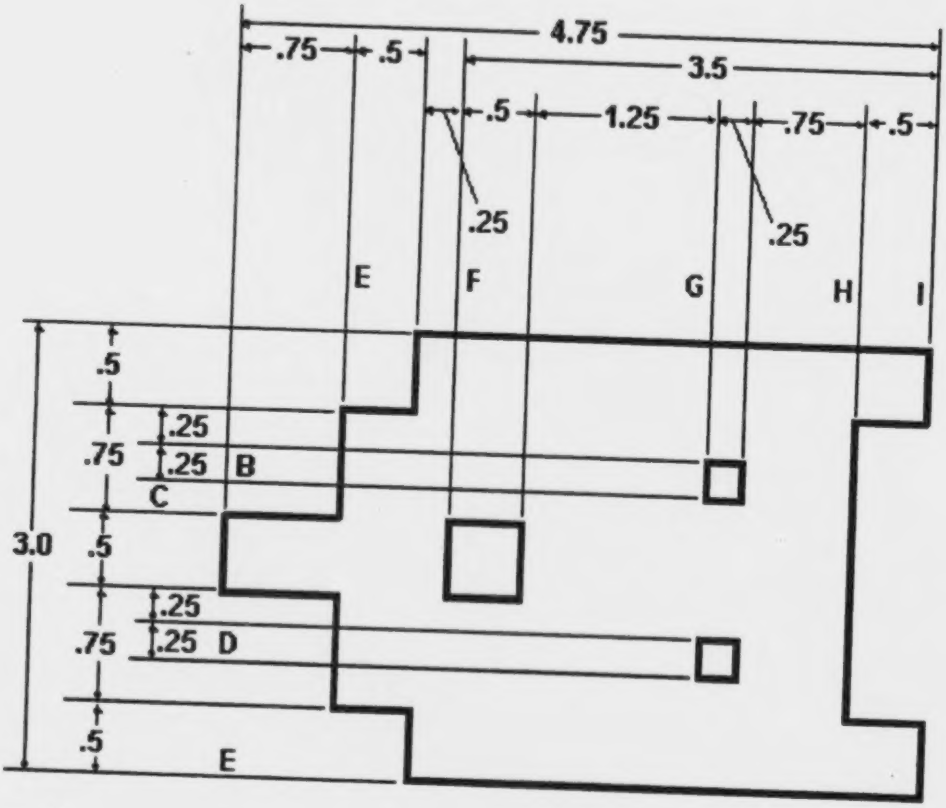
21. What is the distance between Line E and Line F? ____________________

22. What is the distance between Line F and Line G? ____________________

23. What is the distance between Line F and Line I? ____________________

24. What is the distance between Line G and Line H? ____________________

25. What is the distance between Line I and Line E? ____________________


4.75
.75
.5
3.5
.5
1.25
.75
.5
.25
.25
E
F
G
H
I
3.0
.5
.75
.25
.25
B
C
.5
.75
.25
.25
D
.5
E

TLD-B1
Perform Basic Arithmetic Functions
Self-Assessment Answer Key

1. 1/16
2. 1 ½
3. 3/8
4. 3/8
5. 9/16
6. 5.625
7. 23/32
8. 7/32
9. 27/64
10. 3/16
11. 1/3
12. 0.156
13. 1.75
14. 0.375
15. 0.833
16. 0.75
17. 0.25
18. 1.25
19. 1.75
20. 1.0
21. 0.75
22. 1.75
23. 3.25
24. 1.0
25. 4.0

TOOL & DIE and EDM SERIES

MASTER Technical Module No. TLD-B2

Subject: Tool & Die and EDM **Time: 8 Hrs.**

Duty: **Apply Mathematical Concepts**
Task: Perform Basic Algebraic Operations

Objective(s):

Upon completion of this unit the student will be able to:
a. Understand basic algebraic symbols and expressions; and,
b. Use equations to solve problems.

Instructional Materials:

Calculators for Students
MASTER Handout (TLD-B2-HO)
MASTER Self-Assessment

References:

Mathematics for Machine Technology, R. D. Smith, Delmar Publishing, Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:
TLD-B1 "Perform Basic Arithmetic Functions"

Introduction:

Algebra is critical in the workplace because technicians frequently encounter situations that include unknown quantities. The purpose of algebra is to provide a means of mathematically describing any situation so that those unknown quantities can be certainly deduced. In other words, algebra is ***not*** a set series of formulas; rather, it is a *way of thinking about numbers*. As a technician, you will daily take rods and bars of metal and form them into sometimes intricate parts on the lathe or the milling machine. Algebra is the lathe of mathematics—with its processes, you can manipulate numbers as easily as you work bronze or aluminum. Look past the fancy names that have been stuck on the processes and rules of algebra and look at what they *say and do* in common language. Many experienced technicians do algebra every day, *in their heads,* and never even realize what they are doing!

Presentation Outline:

- I. Understand Basic Algebraic Symbols and Expressions
  - A. Symbols
    - 1. Addition “+”
    - 2. Subtraction “-”
    - 3. Multiplication “·”; “x”, and parentheses
    - 4. Division “÷” and “/”
    - 5. Exponents are generally limited to the term “square” in linear measurements. This is the “^{2}“ notation.
  - B. Expressions
    - 1. Sum: the total amount resulting from addition
    - 2. Difference: the remaining amount resulting from subtraction
    - 3. Product: the total amount resulting from multiplication
    - 4. Exponent: a superscript which indicates the number of times a quantity is multiplied by itself
    - 5. Quotient: the amount resulting from division
- II. Use a Few Easy-to-Remember Rules to Solve Equations
  - A. *P*lease *E*xcuse *M*y *D*ear *A*unt *S*ue indicates the order in which equations are solved. Each letter shows one of the algebraic notations or functions: Parentheses, Exponents, Multiply, Divide, Add, Subtract.
    - 1. In the expression $(x - y)^2 + 2x^2 - y^2$, the *p*arentheses, which must be worked first, indicate that y must be subtracted from x. Since we don’t know what x and y are, we can’t do that, and must move on.
    - 2. The next step is to square the term (x - y), as indicated by the *e*xponent. This gives us $x^2 - 2xy + y^2 + 2x^2 - y^2$.
    - 3. There is no operable *m*ultiplication or *d*ivision in this expression, so we move on.
    - 4. Grouping all the like terms to make seeing the answer easier, we have $x^2 + 2x^2 + y^2 - y^2 - 2xy$.
    - 5. *A*dding, we now have $3x^2 + y^2 - y^2 - 2xy$.
    - 6. *S*ubtracting, which is the final step, renders $3x^2 - 2xy$.
  - B. *FOIL* gives the order in which you multiply the terms in expressions. Let us go back to squaring (multiplying by itself) (x - y) from the expression above.
    - 1. *F*irst terms first, so, in (x - y)(x - y), multiply the two x’s first. This give us x^2.
    - 2. *O*utside terms come next, so multiply the first x by the second y. This gives us $x^2 - xy$.
    - 3. *I*nside terms come next, so multiply the first y by the second x. This gives us $x^2 - xy - xy$.

4. *L*ast terms are last, so multiply the two y's. This gives us a complete (if complex) $x^2 - xy - xy + y^2$.
5. Simplifying gives us the expression $x^2 - 2xy + y^2$.

C. Thinking about algebra can be daunting to almost anybody, but once you see that algebra is just juggling done with numbers and with a lot of two-dollar words stuck all over it, algebra becomes rather simple. Remember, algebra is just taking the four basic mathematic operations (addition, subtraction, multiplication, and division) and using them to find out something that you didn't know to start with.

D. Word problems are what you will encounter every day in the shop. Someone will tell you to get so much material and make so many parts from it. As you progress in skill, they will tell you to get such-and-such material and make so many parts from it. Your mastery of basic algebra will make these problems easy to solve.

Practical Application:

Students will be able to perform basic algebraic operations as needed to solve problems and to conduct operations encountered in the manufacturing industry. Taper calculations, thread calculations, and rpm calculations are all based on algebra.

Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-B3) dealing with basic geometric principles.

TLD-B2-HO
Perform Basic Algebraic Operations
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:
- a. Understand basic algebraic symbols and expressions; and,
- b. Use equations to solve problems.

Module Outline:

- I. Understand Basic Algebraic Symbols and Expressions
  - A. Symbols
    - 1. Addition “+”
    - 2. Subtraction “-”
    - 3. Multiplication “·”; “x”, and parentheses
    - 4. Division “÷” and “/”
    - 5. Exponents are generally limited to the term “square” in linear measurements. This is the “^{2}“ notation.
  - B. Expressions
    - 1. Sum: the total amount resulting from addition
    - 2. Difference: the remaining amount resulting from subtraction
    - 3. Product: the total amount resulting from multiplication
    - 4. Exponent: a superscript which indicates the number of times a quantity is multiplied by itself
    - 5. Quotient: the amount resulting from division
- II. Use a Few Easy-to-Remember Rules to Solve Equations
  - A. *P*lease *E*xcuse *M*y *D*ear *A*unt *S*ue indicates the order in which equations are solved. Each letter shows one of the algebraic notations or functions: Parentheses, Exponents, Multiply, Divide, Add, Subtract.
    - 1. In the expression $(x - y)^2 + 2x^2 - y^2$, the *p*arentheses, which must be worked first, indicate that y must be subtracted from x. Since we don't know what x and y are, we can't do that, and must move on.
    - 2. The next step is to square the term $(x - y)$, as indicated by the *e*xponent. This gives us $x^2 - 2xy + y^2 + 2x^2 - y^2$.
    - 3. There is no operable *m*ultiplication or *d*ivision in this expression, so we move on.
    - 4. Grouping all the like terms to make seeing the answer easier, we have $x^2 + 2x^2 + y^2 - y^2 - 2xy$.
    - 5. *A*dding, we now have $3x^2 + y^2 - y^2 - 2xy$.
    - 6. *S*ubtracting, which is the final step, renders $3x^2 - 2xy$.

B. *FOIL* gives the order in which you multiply the terms in expressions. Let us go back to squaring (multiplying by itself) (x - y) from the expression above.

1. *F*irst terms first, so, in $(x - y)(x - y)$, multiply the two x's first. This give us x^2.
2. *O*utside terms come next, so multiply the first x by the second y. This gives us $x^2 -xy$.
3. *I*nside terms come next, so multiply the first y by the second x. This gives us $x^2 - xy - xy$.
4. *L*ast terms are last, so multiply the two y's. This gives us a complete (if complex) $x^2 - xy - xy + y^2$.
5. Simplifying gives us the expression $x^2 - 2xy + y^2$.

C. Thinking about algebra can be daunting to almost anybody, but once you see that algebra is just juggling done with numbers and with a lot of two-dollar words stuck all over it, algebra becomes rather simple. Remember, algebra is just taking the four basic mathematic operations (addition, subtraction, multiplication, and division) and using them to find out something that you didn't know to start with.

D. Word problems are what you will encounter every day in the shop. Someone will tell you to get so much material and make so many parts from it. As you progress in skill, they will tell you to get such-and-such material and make so many parts from it. Your mastery of basic algebra will make these problems easy to solve.

Name____________________________ Date________________________

TLD-B2
Perform Basic Algebraic Operations
Self-Assessment

Answer the following questions by circling the most correct answer.

1. The technician is given an order for 100 six-inch bars of 1" CRS. If the company stores its 1" CRS in ten-foot lengths, how many lengths of 1" CRS must the technician obtain in order to complete the job? You may assume that there is no waste.
   A. Five
   B. Ten
   C. Twenty
   D. Twenty-five
   E. None of the above answers is correct.

2. The technician is now told to turn all those six-inch bars down from 1" to 7/8". How much must the technician take off each bar?
   A. 1/16"
   B. 2/16"
   C. 3/16"
   D. 4/16"
   E. None of the above answers is correct.

3. A technician must bore three holes in a 90° arc. The holes must be equally spaced along the arc, and Hole 1 is at the baseline (0°). What is the angle between Hole 1 and Hole 2?
   A. 15°
   B. 30°
   C. 45°
   D. 60°
   E. None of the above answers is correct.

4. A technician must bore three holes in a 90° arc. The holes must be equally spaced along the arc, and Hole 1 is at the baseline (0°). What is the angle between Hole 1 and Hole 3?
   A. 15°
   B. 30°
   C. 45°
   D. 60°
   E. None of the above answers is correct.

5. From a twelve-inch bar, the technician must cut two pieces such that one piece is twice as long as the other. What are the lengths of the resultant bars?
   A. 2" & 4"
   B. 3" & 6"
   C. 4" & 8"
   D. 5" & 10"
   E. None of the above answers is correct.

6. Whitworth threads require that the depth of the thread be .64 of the length of the pitch of the thread. If the thread pitch is 1/8 inch, what is the depth of the threads?
   A. .195 inch
   B. 5.12 inch
   C. .08 inch
   D. .765 inch
   E. None of the above answers is correct.

7. On spur gears, the tooth thickness equals 1.5708/P (the diametral pitch). If the diametral pitch of the gear is 24, what is the thickness of the teeth?
   A. .065"
   B. .377"
   C. .153"
   D. .655"
   E. None of the above answers is correct.

8. The finishing speed for low-carbon steels is 120 surface feet per minute (CS). The diameter of a given workpiece is 3" (D). Using the formula for determining machine speeds, rpm = (4 x CS)/D, what is the rpm?
   A. 10
   B. 160
   C. 1440
   D. Not enough information is given to solve the problem.
   E. None of the above answers is correct.

9. The technician must cut twenty-four plates, each 3" x 6". If the stock is one foot wide and three feet long, how many plates can the technician cut from one plate? Assume no waste or thickness of cut.
   A. 6
   B. 12
   C. 24
   D. 36
   E. None of the above answers is correct.

10. If the thickness of the saw blade is 1/8", how many bars, each exactly 6" long, can be cut from one three-foot piece of stock?

A. 3
B. 4
C. 5
D. 6
E. None of the above answers is correct.

TLD-B2
Perform Basic Algebraic Operations
Self-Assessment Answer Key

1. A
2. B
3. C
4. E
5. C
6. C
7. A
8. B
9. C
10. C

TLD-B3

TOOL & DIE and EDM SERIES

MASTER Technical Module No. TLD-B3

Subject: **Tool & Die and EDM** **Time: 20 Hrs.**

Duty: **Apply Mathematical Concepts**
Task: Use Basic Geometric Principles

Objective(s):

Upon completion of this module the student will be able to:
a. Calculate angles;
b. Calculate length of triangle sides;
c. Calculate radius, diameter, circumference, and area of a circle; and,
d. Understand the applications of planar geometry to solid forms.

Instructional Materials:

MASTER Handout (TLD-B3-HO);
MASTER Self-Assessment;
Paper
Pencil
Chalk Board
Overhead Projector
Various Geometric Objects

References:

Applied Electronic Math, with Calculators, Tontsch, John W., Latest Edition

Applied Math, Bajpai, Avi C.; Bond, Rodney M.; adapted by Jerry W. Jones, Latest Edition

Applied Math for Technicians, Moore, Claude S.; Griffin, Bennie L.; Polhamus, Edward C., Jr.; {drawings, George E. Morris.}, Latest Edition

Basic Business Math, Dansby, Robert L., Latest Edition

Basic Electronics Math with a Scientific Calculator, by Noll, Edward M., Latest Edition

Becoming a Mental Math Wizard, Lucas, Jerry, Latest Edition

Building Success in Math, Langbort, Carol R.; Thompson, Virginia H., Latest Edition

Business Math Basics, Swindle, Robert E., Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:

TLD-B1 "Perform Basic Arithmetic Functions"
TLD-B2 "Perform Basic Algebraic Operations"

Introduction:

Geometry is used to calculate lengths, angles, arcs, areas, and volumes of various shapes and objects. These shapes and objects are the meat and bread of machining; they are machining's sole purpose for existence. The technician takes a workpiece that may not bear any resemblance at all to the finished part, and turns it into that part. A basic understanding of these shapes and how they relate to each other is necessary to the survival of the technician. These shapes and relationships are also geometry.

Presentation Outline:

I. Some Rules of Angles
  A. Angles are usually expressed in degrees, minutes, and seconds
  B. No angle has more than 360°
  C. Angles have three points which determine them
  D. An angle having 90° is a right angle
II. Triangles
  A. Pythagorean Theorem: $a^2 + b^2 = c^2$
  B. All the angles in a triangle will add up to 180°, every day, every time, every triangle
  C. Have three corners. If one of them is 90°, then it is a right triangle.
  D. The absolute size of a triangle cannot be determined by its angles alone. At least one side must be known.
III. Circle
  A. 360°, every day, every time, every circle
  B. Pi (π) 3.1416 and its importance
  C. $2\pi r = d$, where r is the circle's radius and d, its diameter
IV. Rectangles and Parallelograms
  A. Squares and rectangles
    1. Have four 90° corners
    2. Squares are rectangles all of whose sides are equal
  B. Parallelograms
    1. Have four corners not 90°

2. Have (at least) two parallel sides

V. Relating Planar Geometry to Solid Forms

In reality, planar geometry is an abstract way of looking at *parts* of solid things. Look at a piece of 1" CRS—at each end, it is a circle, so all the rules of circles apply to it, but only when looked at from the end. When you look at it from the sides, the rules for lines apply. So, that piece of 1" CRS, which is actually a cylinder, can be looked at as two circles joined by a line. Square workpieces have the same properties. No matter which way you look at them, each face is a rectangle or a parallelogram; and each face is subject to the rules of rectangles and parallelograms. Tapers are unequal circles joined by an incomplete triangle.

Practical Application:

Students will practice working math problems.

Evaluation and/or Verification:

Successful completion of this Technical Module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the handout (TLD-B3-HO) as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-B4) dealing with performing basic trigonometric operations.

TLD-B3-HO
Use Basic Geometric Principles
Attachment 1: **MASTER** Handout

Objective(s):

Upon completion of this module the student will be able to:

- a. Calculate angles;
- b. Calculate length of triangle sides;
- c. Calculate radius, diameter, circumference, and area of a circle; and,
- d. Understand the applications of planar geometry to solid forms.

Module Outline:

- I. Some Rules of Angles
  - A. Angles are usually expressed in degrees, minutes, and seconds
  - B. No angle has more than 360°
  - C. Angles have three points which determine them
  - D. An angle having 90° is a right angle
- II. Triangles
  - A. Pythagorean Theorem: $a^2 + b^2 = c^2$
  - B. All the angles in a triangle will add up to 180°, every day, every time, every triangle
  - C. Have three corners. If one of them is 90°, then it is a right triangle.
  - D. The absolute size of a triangle cannot be determined by its angles alone. At least one side must be known.
- III. Circle
  - A. 360°, every day, every time, every circle
  - B. Pi (π) 3.1416 and its importance
  - C. $2\pi r = d$, where r is the circle's radius and d, its diameter
- IV. Rectangles and Parallelograms
  - A. Squares and rectangles
    - 1. Have four 90° corners
    - 2. Squares are rectangles all of whose sides are equal
  - B. Parallelograms
    - 1. Have four corners not 90°
    - 2. Have (at least) two parallel sides
- V. Relating Planar Geometry to Solid Forms

In reality, planar geometry is an abstract way of looking at *parts* of solid things. Look at a piece of 1" CRS—at each end, it is a circle, so all the rules of circles apply to it, but only when looked at from the end. When you look at it from the sides, the rules for lines apply. So, that piece of 1" CRS, which is actually a cylinder, can be looked at as two circles joined by a line. Square workpieces have the same properties. No matter which way you look at them, each face is a rectangle or a parallelogram; and each face is subject to the rules of rectangles and parallelograms. Tapers are unequal circles joined by an incomplete triangle.

Name________________________ Date______________________

TLD-B3
Use Basic Geometric Principles
Self-Assessment

Solve the following problems:

1. The technician is told to turn down a three-inch piece of 1" CRS to 3/4". What is the length of the new radius of the CRS?
   - A. .750"
   - B. .500"
   - C. .375"
   - D. .125"
   - E. None of the above answers is correct.

2. The technician must bore six 1" holes in a plate. The holes must be bored in a eight-inch diameter circle and must be equally spaced. How many degrees apart are the holes?
   - A. 30°
   - B. 60°
   - C. 90°
   - D. 120°
   - E. None of the above answers is correct.

3. The technician must cut triangular iron plates for a construction project. One angle is 80° and one of the others is 50°. What is the measure of the third angle?
   - A. 230°
   - B. 165°
   - C. 50°
   - D. Not enough information is given to solve the problem.
   - E. None of the above answers is correct.

4. The technician is given six discs, each 3" in diameter. Each disc must be bored so that it produces an eccentricity of 1/2". How far off center does the technician drill the hole?
   - A. 1/8"
   - B. 1/4"
   - C. 1/2"
   - D. 1/4π"
   - E. None of the above answers is correct.

5. The technician must cut a set of 1/2" square teeth along the top of a 6' rectangular rod. The top flat and the valley flat are equal and each end of the rod ends in a top flat. How many valley flats must be cut? (Note: There will be scrap.)
   A. 36
   B. 71
   C. 70
   D. 102
   E. None of the above answers is correct.

TLD-B3
Use Basic Geometric Principles
Self-Assessment Answer Key

1. C

2. B

3. C

4. B

5. B

TOOL & DIE and EDM SERIES

MASTER Technical Module No. TLD-B4

Subject: **Tool & Die and EDM** **Time: 4 Hrs.**

Duty: **Apply Mathematical Concepts**
Task: Perform Basic Trigonometric Operations

Objective(s):

Upon completion of this unit the student will be able to:

a. Solve for unknown angles;
b. Solve for unknown sides; and,
c. Calculate bolt hole patterns.

Instructional Materials:

Scientific Calculator capable of trigonometric functions
MASTER Handout (TLD-B4-HO)
MASTER Laboratory Aid (TLD-B4-LA)
MASTER Self-Assessment

References:

Machinery's Handbook, Industrial Press, Latest Edition, "Solution of Triangles"
Student's Shop Reference Handbook, Industrial Press, Latest Edition, "Mathematics: Solution of Triangles"

Student Preparation:

Students should have previously completed the following Technical Modules:
TLD-B1 "Perform Basic Arithmetic Functions"

Introduction:

Trigonometry for the technician is actually quite simple. There is nothing to memorize and the calculations are easy. It is important, however, to the operation of several measuring devices and tools.

Presentation Outline:

- I. Solve for Unknown Angles
  - A. Right triangles
    - 1. Sine Law: sin a = side opposite divided by hypotenuse
    - 2. Cosine Law: cos a = side adjacent divided by hypotenuse
    - 3. Tangent Law: tan a = side opposite divided by side adjacent
    - 4. *O*scar *H*as *A* *H*eap *O*f *A*pples is a quick device to remember the above three runes.
      - a. Sine ∠ = *O*pposite/*H*ypoteneuse
      - b. Cosine ∠ = *A*djacent/*H*ypoteuse
      - c. Tangent ∠ = *O*pposite/*A*djacent
  - B. Oblique Triangles
    - 1. Lengths of three sides (A, B, C) all known
      - a. Cos $a = (B^2 + C^2 - A^2)/2BC$
      - b. Sin $b = (B \times \sin a)/A$
      - c. $c = 180^\circ - (a + b)$
    - 2. Two angles (a and b) known
      $c = 180^\circ - (a + b)$
    - 3. Two sides and interior angle (A, c, B) known
      - a. Tan $a = (A \times \sin c)/B-(A \times \cos c)$
      - b. $b = 180^\circ - (a + c)$
      - c. $C = (A \times \sin c)/\sin a$
    - 4. Two sides and an opposite angle (a, A, B) known
      - a. Sin $b = (B \times \sin a)/A$
      - b. $c = 180^\circ - (a + b)$
      - c. $C = (A \times \sin c)/\sin a$
- II. Solve for Unknown Sides
  - A. Right triangles, any two sides known, where C is the hypotenuse
    $A^2 + B^2 = C^2$
  - B. One side and two angles (a, b, A) known
    - 1. $c = 180^\circ - (a + b)$
    - 2. $B = (A \times \sin b)/\sin a$
    - 3. $C = (A \times \sin c)/\sin a$
  - C. Two sides and the interior angle (A, B, c) known
    $C = \sqrt{[A^2 + B^2 - (2AB \times \cos c)]}$
  - D. Three angles known
    It is impossible to determine the actual length of any side when only the sizes of the three angles are known. The length of at least one side *must* be known in order to calculate the lengths of the other sides.
- III. Calculate Bolt Hole Patterns
  - A. Discuss the construction of reference triangles to solve bolt-hole patterns
  - B. Discuss circles and their uses in figuring bolt-hole patterns.

Practical Application:

Students will display the ability to correctly lay out bolt hole patterns and to compute angular distances using trigonometry. This module also prepares students for the use of sine bars and sine plates.

Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-B5) dealing with using and applying Cartesian coordinate system.

TLD-B4-HO
Perform Basic Trigonometric Operations
Attachment 1: **MASTER** Handout

Objective(s):

Upon completion of this unit the student will be able to:

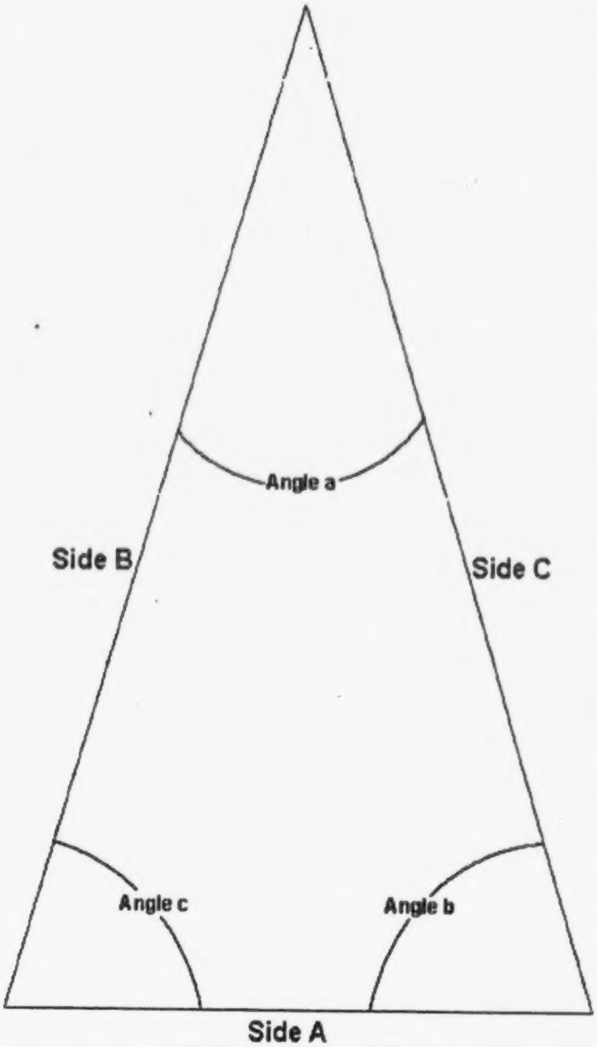
- a. Solve for unknown angles;
- b. Solve for unknown sides; and,
- c. Calculate bolt hole patterns.

Module Outline:

- I. Solve for Unknown Angles
  - A. Right triangles
    - 1. Sine Law: sin a = side opposite divided by hypotenuse
    - 2. Cosine Law: cos a = side adjacent divided by hypotenuse
    - 3. Tangent Law: tan a = side opposite divided by side adjacent
    - 4. *O*scar *H*as *A* *H*eap *Of* *A*pples is a quick device to remember the above three runes.
      - a. Sine ∠ = *O*pposite/*H*ypoteneuse
      - b. Cosine ∠ = *A*djacent/*H*ypoteuse
      - c. Tangent ∠ = *O*pposite/*A*djacent
  - B. Oblique Triangles
    - 1. Lengths of three sides (A, B, C) all known
      - a. Cos $a = (B^2 + C^2 - A^2)/2BC$
      - b. Sin $b = (B \times \sin a)/A$
      - c. $c = 180° - (a + b)$
    - 2. Two angles (a and b) known
      $c = 180° - (a + b)$
    - 3. Two sides and interior angle (A, c, B) known
      - a. Tan $a = (A \times \sin c)/B-(A \times \cos c)$
      - b. $b = 180° - (a + c)$
      - c. $C = (A \times \sin c)/\sin a$
    - 4. Two sides and an opposite angle (a, A, B) known
      - a. Sin $b = (B \times \sin a)/A$
      - b. $c = 180° - (a + b)$
      - c. $C = (A \times \sin c)/\sin a$
- II. Solve for Unknown Sides
  - A. Right triangles, any two sides known, where C is the hypotenuse
    $A^2 + B^2 = C^2$
  - B. One side and two angles (a, b, A) known
    - 1. $c = 180° - (a + b)$
    - 2. $B = (A \times \sin b)/\sin a$

        3. $C = (A \times \sin c)/\sin a$
    - C. Two sides and the interior angle (A, B, *c*) known
      $C = \sqrt{[A^2 + B^2 - (2AB \times \cos c)]}$
    - D. Three angles known
      It is impossible to determine the actual length of any side when only the sizes of the three angles are known. The length of at least one side *must* be known in order to calculate the lengths of the other sides.
- III. Calculate Bolt Hole Patterns
    - A. Discuss the construction of reference triangles to solve bolt-hole patterns
    - B. Discuss circles and their uses in figuring bolt-hole patterns.

TLD-B4-LA
Perform Basic Trigonometric Operations
Attachment 2: MASTER Laboratory Aid


Angle a
Side B
Side C
Angle c
Angle b
Side A

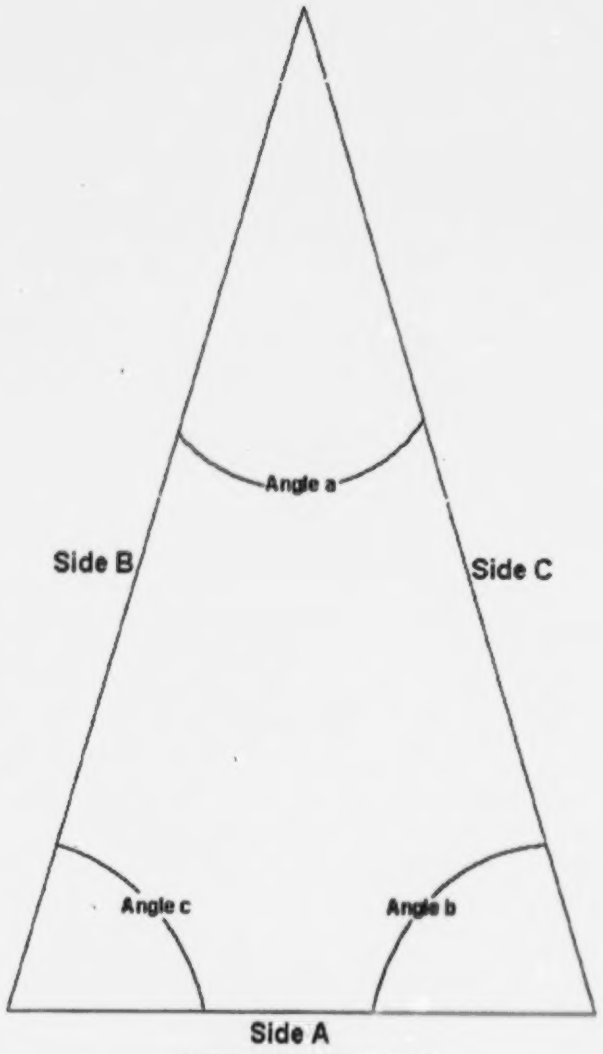
Basic Triangle - TLD-B4

Name____________________________ Date_______________

TLD-B4
Perform Basic Trigonometric Operations
Self-Assessment

Using the reference triangle on the accompanying page, solve the following triangles from the information given. Show all work.

1. Side A = 9"; Side B = 8"; Side C = 12"; solve for all angles. The triangle is oblique.
2. Side A = 6 cm; Angle *c* = 60°; Side B = 12 cm; solve for Angle *a*..
3. Angle *a* = 35°; Angle *b* = 57° 30'; solve for Angle *c*.
4. Angle *a* = 40°; Side A = 18"; Side B = 12"; solve for Angles *b* & *c*.
5. Side A = cm; Angle *c* = 90°; Side B = 12 cm; solve for Side C.
6. Angle *a* = 22° 30'; Angle *b* = Angle *a*; Side A = 9"; solve for Sides B & C.
7. Side A = 12 cm; Side B = 12 cm; Angle *c* = 60°; solve for Side C.
8. The triangle is a right triangle. Side A = 3'; Side B = 4'; Side C = 5'; solve for all angles.
9. A right triangle has two 45° angles. Solve for the sides, in inches.

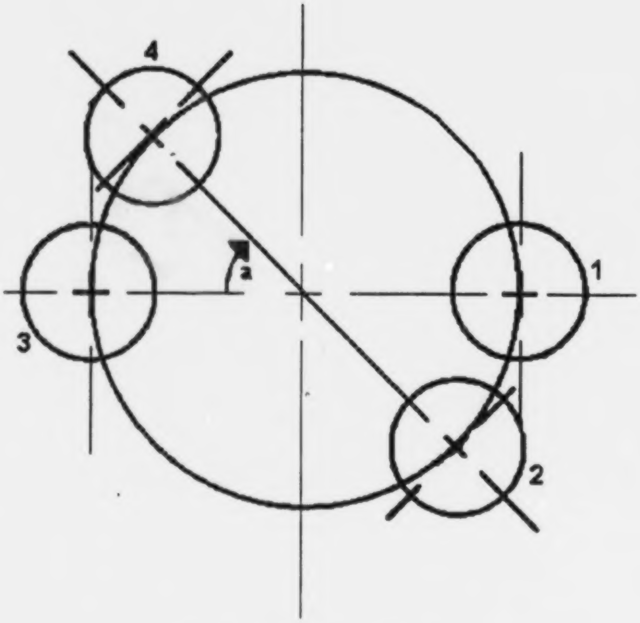

Angle a
Side B
Side C
Angle c
Angle b
Side A

Basic Triangle - TLD-B4

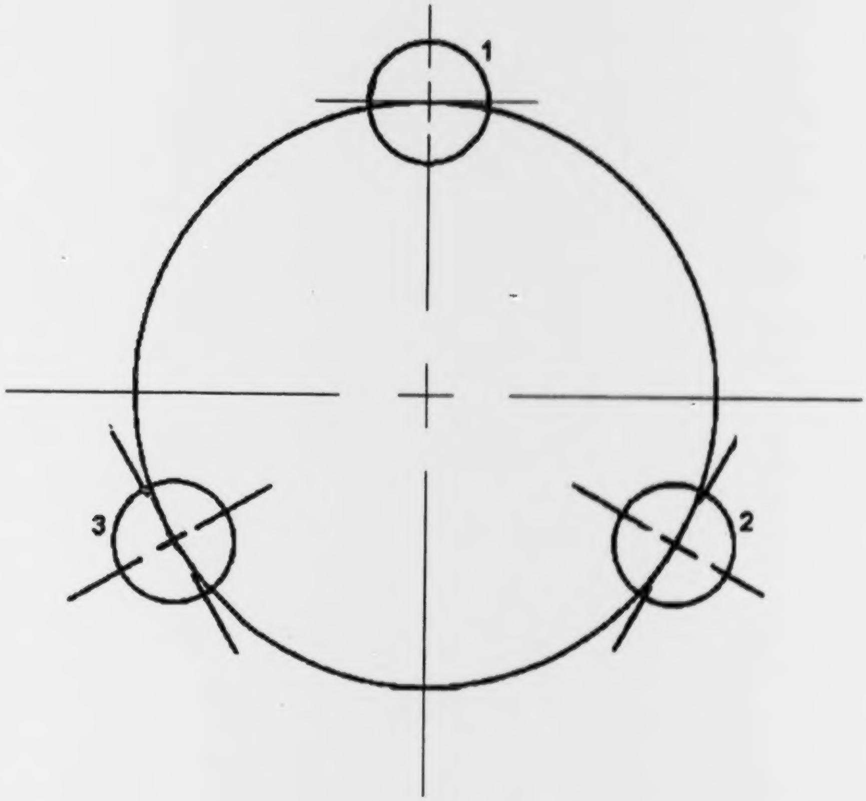
Using the two bolt-hole patterns shown in the illustrations on the accompanying page, solve the following questions. Remember that the answers should be in the form of *x,y*.

10. Four holes are spaced around a 2" semi-circle. If Hole One is at 1,0; where are the other three holes?

11. Three equally-spaced holes around a 6" diameter reference circle. If Hole One is at 0,3; where are the other two holes?



Question No. 10 - TLD-B4



Question No. 11 - TLD-B4

TLD-B4
Perform Basic Trigonometric Operations
Self-Assessment Answer Key

1. a = 48.59° b = 41.81° c = 89.6°

2. a = 86.11°

3. c = 87° 30'

4. b = 25.37° c =114.63°

5. Side C = 13.41 cm

6. Side B = 9" Side C = 16.63"

7. Side C = 12 cm

8. Angle a = 36.87° Angle b = 53.13° Angle c = 90°

9. The problem is impossible to solve.

10. Hole 1: 1,0 Hole 2: 0.7071, -0.7071
    Hole 3: -1,0 Hole 4: -0.7071, 0.7071

11. Hole 1: 0, 3 Hole 2: 0.866, -0.500 Hole 3: -0.500, -0.866

TOOL & DIE and EDM SERIES

MASTER Technical Module No. TLD-B5

Subject: Tool & Die and EDM **Time: 6 Hrs.**

Duty: Apply Mathematical Concepts
Task: Use and Apply Cartesian Coordinate System

Objective(s):

Upon completion of this unit the student will be able to:

a. Identify points using the Cartesian coordinate system;
b. Identify points using the absolute dimensioning system;
c. Identify points using the incremental dimensioning system; and,
d. Identify points using the polar coordinate system.

Instructional Materials:

Scientific calculator
MASTER Handout (TLD-B5-HO)
MASTER Self-Assessment

References:

Student's Shop Reference Handbook, Industrial Press, Latest Edition, "Mathematics"

Student Preparation:

Students should have previously completed the following Technical Modules:
MLD-B1 "Perform Basic Arithmetic Functions"

Introduction:

Many operations which the technician must perform require the location of holes or other machining locations from a datum or origin point. Many drawings are dimensioned such that part features must be located in reference to another point or part feature. Many of today's machine tools have been fitted with digital read-out equipment which allow the technician to quickly set and move to the required machining locations. Virtually all of the CNC machines in use today require that the technician be able to locate and program machining locations using the Cartesian coordinate or the polar coordinate systems. It is, therefore, imperative that the technician understand and be able to use these coordinate systems.

Presentation Outline:

- I. Identify Points Using the Cartesian Coordinate System
  - A. Describe the Cartesian (rectangular) coordinate system - the basis for all machine movement
    - 1. Define *axis* - any direction of movement on a machine tool. The spindle is always defined as the Z axis on 3 axis systems.
    - 2. Discuss the plus and minus aspects of an axis
    - 3. Discuss the quadrants I, II, III, and IV. Note that the signs for the X- and Y-axes change for the different quadrants.
    - 4. Discuss the concept of three dimensional locations
    - 5. Discuss how points are described in both 2- and 3-axis systems
    - 6. Describe how a part fits into the axis system
- II. Identify Points Using the Polar Coordinate System
  - A. Describe the *polar coordinate system* - a system by which all points are located around a known location (or pole).
    - 1. Points are usually identified by a known distance from the pole and a given angle from the horizontal (3:00 o'clock position equals zero degrees)
    - 2. Positive angles are measured from angle zero in a counterclockwise direction
    - 3. Negative angles are measured from angle zero in a clockwise direction
  - B. Student practice
- III. Locate Points Using the Absolute Dimensioning System
  - A. Define *absolute positioning*- in absolute positioning, all machine locations are taken from one fixed zero (origin) point. This origin point does not change.
  - B. This corresponds to the datum dimensioning method used by drafters. In datum dimensioning, all dimensions on a drawing are placed in reference to one fixed zero point.
  - C. Student practice
- IV. Locate Points Using the Incremental Dimensioning System
  - A. Define *incremental positioning*- in incremental positioning, the X0/Y0 moves with each position change. The current position, in fact, becomes the X0/Y0 for the next positioning move.
  - B. This corresponds to the delta dimensioning method used by drafters. In delta dimensioning, all dimensions on a drawing are "chain-linked." Each location is dimensioned from the previous one.
  - C. Student practice

Practical Application:

Students will be able to calculate boring and cutting patterns for those machines which use datum-point controls.

Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (MLD-C1) dealing with interpreting and understanding basic layout/types of drawings.

TLD-B5-HO
Use and Apply Cartesian Coordinate System
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

- a. Identify points using the Cartesian coordinate system;
- b. Identify points using the absolute dimensioning system;
- c. Identify points using the incremental dimensioning system; and,
- d. Identify points using the polar coordinate system.

Module Outline:

- I. Identify Points Using the Cartesian Coordinate System
  - A. Describe the Cartesian (rectangular) coordinate system - the basis for all machine movement
    - 1. Define *axis* - any direction of movement on a machine tool. The spindle is always defined as the Z axis on 3 axis systems.
    - 2. Discuss the plus and minus aspects of an axis
    - 3. Discuss the quadrants I, II, III, and IV. Note that the signs for the X- and Y-axes change for the different quadrants.
    - 4. Discuss the concept of three dimensional locations
    - 5. Discuss how points are described in both 2- and 3-axis systems
    - 6. Describe how a part fits into the axis system
- II. Identify Points Using the Polar Coordinate System
  - A. Describe the *polar coordinate system* - a system by which all points are located around a known location (or pole).
    - 1. Points are usually identified by a known distance from the pole and a given angle from the horizontal (3:00 o'clock position equals zero degrees)
    - 2. Positive angles are measured from angle zero in a counterclockwise direction
    - 3. Negative angles are measured from angle zero in a clockwise direction
  - B. Student practice
- III. Locate Points Using the Absolute Dimensioning System
  - A. Define *absolute positioning*- in absolute positioning, all machine locations are taken from one fixed zero (origin) point. This origin point does not change.
  - B. This corresponds to the datum dimensioning method used by drafters. In datum dimensioning, all dimensions on a drawing are placed in reference to one fixed zero point.
  - C. Student practice

IV. Locate Points Using the Incremental Dimensioning System
  A. Define *incremental positioning*- in incremental positioning, the X0/Y0 moves with each position change. The current position, in fact, becomes the X0/Y0 for the next positioning move.
  B. This corresponds to the delta dimensioning method used by drafters. In delta dimensioning, all dimensions on a drawing are "chain-linked." Each location is dimensioned from the previous one.
  C. Student practice

Name____________________________ Date_______________

TLD-B5
Use and Apply Cartesian Coordinate System
Self-Assessment

Circle the letter preceding the correct answer.

1. Using the Cartesian plane shown (Diagram 1), what can be said of point 1, regardless of the values of the actual coordinates?
   A. X is positive and Y is positive.
   B. X is positive and Y is negative.
   C. X is negative and Y is positive.
   D. X is negative and Y is negative.
   E. None of the above answers is correct.

2. Using Diagram 1, what can be said of point 2, regardless of the actual values of the coordinates?
   A. X is positive and Y is positive.
   B. X is positive and Y is negative.
   C. X is negative and Y is positive.
   D. X is negative and Y is negative.
   E. None of the above answers is correct.

3. Which of the following statements is **not** true?
   A. In absolute dimensioning, all machine locations are taken from a point called the *origin* or *zero point*.
   B. The origin point is fixed.
   C. Absolute dimensioning corresponds the drafting method known as *datum dimensioning*.
   D. In datum dimensioning, all dimensions are determined from a single, fixed point.
   E. All of the above statements are true.

4. Incremental positioning:
   A. Corresponds to the drafting method known as *delta dimensioning*.
   B. Moves the X0/Y0 point after each operation.
   C. Has "chain-linked" dimensions on the blueprints.
   D. All of the above answers are applicable to the question.
   E. None of the above answers is correct.

5. In a three-axis system, the spindle always corresponds to the:
   A. X-axis.
   B. Y-axis.
   C. Z-axis.
   D. The correspondence of the spindle is not standard.
   E. None of the above answers is correct.

6. In the *polar coordinate* system, points are identified by a known distance from the pole and a known ___ from the horizon.
   A. Angle
   B. 3:00 o'clock position
   C. Horizon
   D. Pole
   E. None of the above answers is correct.

For questions 7 through 9, all holes are 3/8 inch diameter and the workpiece setup point corresponds to a point of 6,4 from the table origin.

7. Using Diagram 2 and the absolute dimensioning system, dimension program the part. Show all work. All measurements are in inches.

Hole	X	Y
A		
B		
C		

8. Using Diagram 2 and the incremental dimensioning system, dimension program the part. Show all work. All measurements are in inches.

Hole	X	Y
A		
B		
C		

9. Using Diagram 3 and the absolute dimensioning system, dimension program the part. Show all work; all linear measurements are in inches.

Hole	X	Y
A		
B		
C		
D		
E		

10. Using Diagram 3 and the incremental dimensioning system, dimension program the part. Show all work; all linear measurements are in inches.

Hole	X	Y
A		
B		
C		
D		
E		

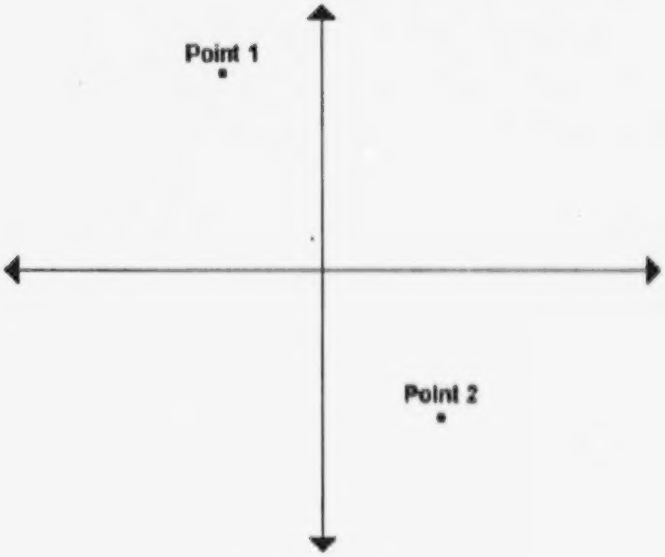

Point 1
Point 2

Diagram 1 - TLD-B5

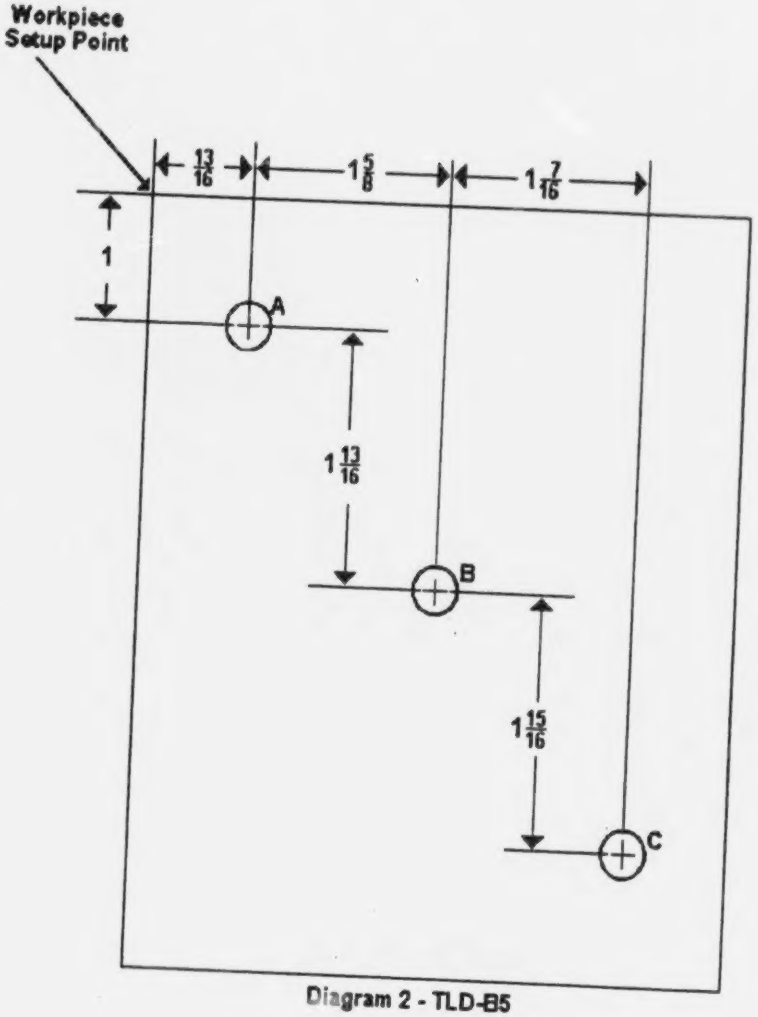

Workpiece Setup Point
13/16
1 5/8
1 7/16
1
A
1 13/16
B
1 15/16
C

Diagram 2 - TLD-B5

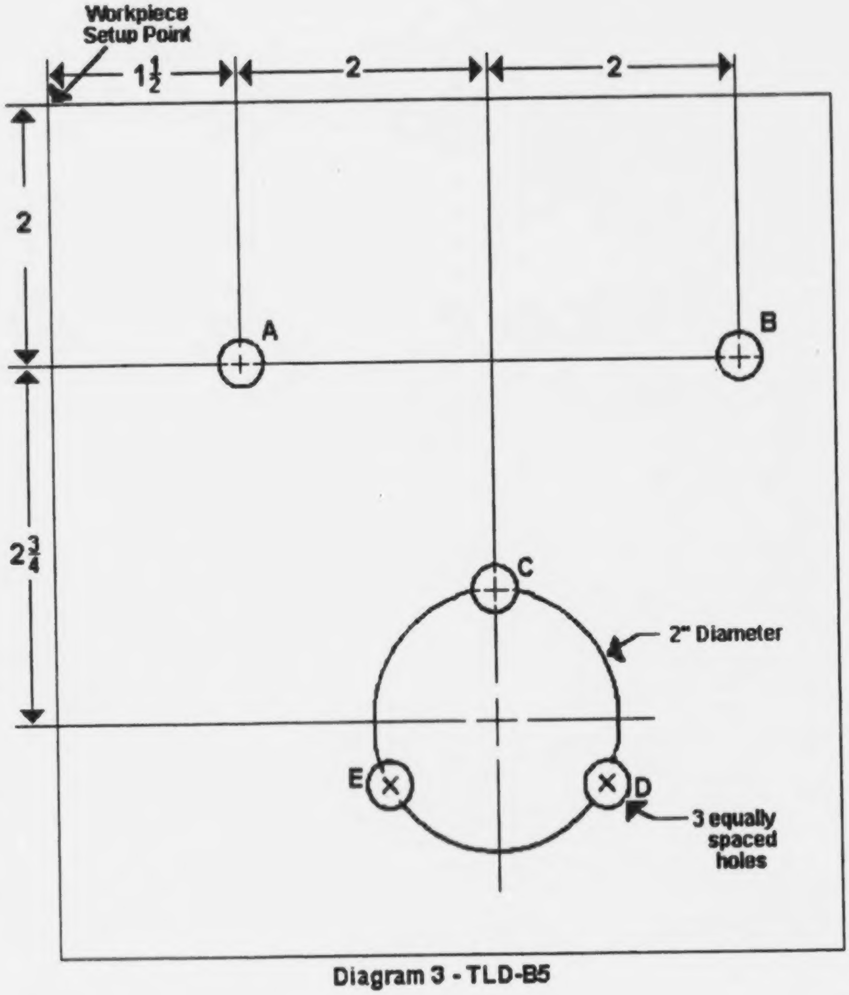

Workpiece Setup Point
1½
2
2
2
A
B
2¾
C
2" Diameter
E
D
3 equally spaced holes

Diagram 3 - TLD-B5

TLD-B5
Use and Apply Cartesian Coordinate System
Self-Assessment Answer Key

1. C

2. D

3. E

4. D

5. C

6. A

7.

Hole	X	Y
A	6 13/16	3
B	8 7/16	1 3/16
C	9 7/8	-3/4

8.

Hole	X	Y
A	6 13/16	3
B	1 5/8	-1 13/16
C	1 7/16	-1 15/16

9.

Hole	X	Y
A	7 ½	2
B	11 ½	2
C	9 ½	1/4
D	10 23/64	-1 1/4
E	8 37/64	-1 1/4

10.

Hole	X	Y
A	7 ½	2
B	4	0
C	-2	-1 3/4
D	55/64	-1 ½
E	-1 23/32	0

TOOL AND DIE MAKER .... skilled workers who produce tools, dies, and special guiding and holding devices that are used in machining.

	Duties	Tasks												
A	Practice Safety	A-1 Follow safety manuals and all safety regulations/requirements	A-2 Maintain safe equipment and machinery	A-3 Use safe operating procedures for hand and machine tools	A-4 Maintain a clean and safe work environment	A-5 Use safe material handling practices	A-6 Consult and apply MSDS for hazards of various materials							
B	Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Perform basic algebraic operations	B-3 Use basic geometric principles	B-4 Perform basic trigonometric functions	B-5 Use and apply Cartesian Coordinate System								
C	Interpret Engineering Drawings and Related Documents	C-1 Interpret and understand basic layout/types of drawings	C-2 Interpret, review, and apply blueprint notes, dimensions, and tolerances	C-3 Use and apply Geometric Dimensioning and Tolerancing (GD&T)	C-4 Demonstrate traditional mechanical drafting and sketching techniques	C-5 Understand and use quality systems								
D	Demonstrate Knowledge of Manufacturing Materials	D-1 Identify materials with desired properties	D-2 Identify materials and processes to produce a part	D-3 Discuss classification systems for metal										
E	Measure/Inspect	E-1 Understand metrology terms	E-2 Select measurement tools	E-3 Measure with hand held instruments	E-4 Eliminate measurement variables	E-5 Measure/inspect using surface plate and accessories	E-6 Inspect using stationary equipment							
F	Demonstrate Knowledge of Manufacturing Processes	F-1 Discuss metal cutting and metal cutting tools	F-2 Operate metal saws	F-3 Operate drill presses and tooling	F-4 Operate engine and turret lathes and tooling	F-5 Operate vertical and horizontal mills and tooling	F-6 Operate precision grinders	F-7 Operate heat treating equipment and processes	F-8 Operate sheet metal equipment	F-9 Operate welding equipment and processes	F-10 Estimate time required/cost to produce a part			
G	Use Computers	G-1 Use computer operating systems	G-2 Understand computer terminology	G-3 Use file management systems	G-4 Install and use software packages									
H	Perform CAD/CAM and CNC Programming Tasks	H-1 Discuss fundamentals of CNC machines and controls	H-2 Program and operate CNC milling machine and machining center	H-3 Program and operate CNC lathe	H-4 Use Computer-Aided Drafting (CAD) system	H-5 Create 3-D solid models	H-6 Use Computer-Aided Manufacturing (CAM) system							
I	Perform Tool and Die Making Operations	I-1 Discuss basic types and functions of jigs and fixtures	I-2 Utilize concepts of jig and fixture design	I-3 Demonstrate understanding of different types of industrial dies	I-4 Utilize basic die theory	I-5 Utilize principles of die design	I-6 Perform tool and die repair	I-7 Demonstrate tool and die making skills						
J	Operate Electrical Discharge Machine (EDM)	J-1 Discuss fundamentals of EDM	J-2 Setup and operate conventional sinker EDM	J-3 Program, setup, and operate CNC sinker EDM and EDM drill	J-4 Program, setup, and operate CNC wire EDM									

TLD FM8
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DutyC

TOOL & DIE and EDM SERIES

MASTER Technical Module No. TLD-C1

Subject: **Tool & Die and EDM** **Time: 6 Hrs.**

Duty: **Interpret Engineering Drawings and Related Documents**
Task: Interpret and Understand Basic Layout/Types of Drawings

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Objective(s):

Upon completion of this unit the student will be able to:
a. Identify types of drawings;
b. Identify parts of a drawing and list components of each;
c. Identify types of lines on a drawing;
d. List and describe the different views found on a drawing;
e. List and apply the three primary planes of projection;
f. List and apply the six principle views;
g. Apply auxiliary views; and,
h. Apply sectional views.

Instructional Materials:

MASTER Handout (TLD-C1-HO)
MASTER Self-Assessment

References:

Technical Drawing, Fredricke Giesecke, Alva Mitchell, Henry Cecil Spencer, Ivan Leroy Hill, John Thomas Dygdon, and James E. Novack, Macmillan, Latest Edition
Basic Blueprint Reading, Pamela Smith, Developed by Industrial Services Staff, Research and Curriculum Unit, Mississippi State University for Division of Vocational - Technical Education, Mississippi State Department of Education, Latest Edition
Technical Drawing, David L. Goetsch, John A. Nelson, and William S. Chalk, Delmar Publishing Inc., Latest Edition
Mechanical Drafting, David Madsen, Terence M. Schumaker and Susan A. Stewart, Delmar Publishing Inc., Latest Edition
Engineering Graphics, Fredrick E. Giesecke, Alva Michell, Henry Cecil Spencer, Ivan Leroy Hill, Robert Olin Loving, John Thomas Dygdon, James E. Novack, Macmillan Publishing Co., Latest Edition
Engineering Drawing and Design, Cecil Jensen, Jay Helsel, and Dennis Short, Glencoe, McGraw-Hill, Latest Edition (textbook and CD-ROM)

Machinery's Handbook, Erik Oberg, Franklin D. Liones, and Holbrook L. Horton, Industrial Press, Latest Edition

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Student Preparation:

Introduction:

In industrial work the blueprint is the guidepost and the primary means of communication. The blueprint represents communication between engineering and process manufacturing. Tool and die makers need to know how to read and interpret a blueprint accurately and then build the products as cost effectively as possible. The process of building a better understanding of basic layouts and types of drawings will facilitate each stage of production until the product is completed.

Presentation Outline:

I. Interpret and Understand Basic Layout of Drawings
  A. ANSI & ISO sheet size layout
  B. ANSI & ISO forms of lettering arrangements
II. Interpret and Understand Types of Drawings
  A. Orthographic and multi-view projection
  B. Perspective or central projection
  C. Oblique projection
  D. Axonometric projection
III. Identify Parts of a Blue Print/Drawing and List Components of Each
  A. Body
  B. Title block
    1. Drawing number
    2. Drawing title
    3. Scale
    4. Signatures
    5. Job number
    6. Material list number
    7. Reference drawings
    8. Distribution section
    9. Revision
    10. Work order number
  C. Bill of Materials
    1. Piece mark number
    2. Number of pieces required for each piece mark
    3. Description of materials
    4. Traceability requirements

    - 5. Material specifications
    - 6. Length
    - 7. Gross weight
    - 8. Total weight
- IV. Identify Types of Lines on a Drawing
  - A. Visible line
  - B. Hidden line
  - C. Center line
  - D. Section line
  - E. Dimension line
  - F. Extension line
  - G. Leaders line
  - H. Cutting plane/viewing plane line
  - I. Short-break line
  - J. Long-break line
  - K. Phantom line
  - L. Stitch line
  - M. Chain line
  - N. Cylindrical break/conventional break lines
- V. List and Describe the Different Views Found on a Drawing
  - A. One view
    - 1. Sphere
    - 2. Plate
  - B. Two view
    - 1. Cylinder
    - 2. Rectangle
  - C. Three view
    - 1. Pyramids
    - 2. Multi-view projection
- VI. List and Apply the Three Primary Planes of Projection
  - A. Frontal projection plane
  - B. Profile projection plane
    - 1. Right side
    - 2. Left side
  - C. Horizontal projection plane
- VII. List and Apply the Six Principal Views
  - A. Front view
  - B. Rear view
  - C. Right side view
  - D. Left side view
  - E. Top view
  - F. Bottom view
- VIII. List and Apply Auxiliary Views
  - A. Surfaces needing auxiliary views
    - 1. Inclined surfaces

        2. Oblique surfaces
    B. Primary auxiliary views
    C. Secondary auxiliary views
    D. To generate an auxiliary view
        1. Folding-line method
        2. Reference-plane method
    E. Classifications of auxiliary views
        1. Depth auxiliary views
        2. Height auxiliary views
        3. Width auxiliary views
    F. Dihedral angles
    G. Partial auxiliary views
    H. Half auxiliary views
    I. Auxiliary sections
    J. Basic four uses of auxiliary views
        1. True length of line
        2. Point view of line
        3. Edge view of plane
        4. True size of plane

IX. List and Apply Sectional Views
    A. Need for sectional views
    B. Cutting plane
        1. Direction
        2. Labels
        3. Alternate styles
    C. Section lining
        1. Techniques
        2. Symbols
    D. Types of sectional views
        1. Full section
        2. Half/partial section
        3. Broken-out section
        4. Revolved section
        5. Removed section
        6. Offset section
        7. Aligned section
        8. Auxiliary section
        9. Partial section

Practical Application:

Students should be given several drawings of various types with varying degrees of complexity to read and answer questions about.

Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this lesson, along with successful completion of blueprint reading exercises.

Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-C2) dealing with interpreting, reviewing, and applying blueprint notes, dimensions, and tolerances.

TLD-C1-HO
Interpret and Understand Basic Layout/Types of Drawings
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

- a. Identify types of drawings;
- b. Identify parts of a drawing and list components of each;
- c. Identify types of lines on a drawing;
- d. List and describe the different views found on a drawing;
- e. List and apply the three primary planes of projection;
- f. List and apply the six principle views;
- g. Apply auxiliary views; and,
- h. Apply sectional views.

Module Outline:

- I. Interpret and Understand Basic Layout of Drawings
  - A. ANSI & ISO sheet size layout
  - B. ANSI & ISO forms of lettering arrangements
- II. Interpret and Understand Types of Drawings
  - A. Orthographic and multi-view projection
  - B. Perspective or central projection
  - C. Oblique projection
  - D. Axonometric projection
- III. Identify Parts of a Blue Print/Drawing and List Components of Each
  - A. Body
  - B. Title block
    - 1. Drawing number
    - 2. Drawing title
    - 3. Scale
    - 4. Signatures
    - 5. Job number
    - 6. Material list number
    - 7. Reference drawings
    - 8. Distribution section
    - 9. Revision
    - 10. Work order number
  - C. Bill of Materials
    - 1. Piece mark number
    - 2. Number of pieces required for each piece mark
    - 3. Description of materials
    - 4. Traceability requirements

    - 5. Material specifications
    - 6. Length
    - 7. Gross weight
    - 8. Total weight
- IV. Identify Types of Lines on a Drawing
  - A. Visible line
  - B. Hidden line
  - C. Center line
  - D. Section line
  - E. Dimension line
  - [illegible] Extension line
  - G. Leaders line
  - H. Cutting plane/viewing plane line
  - I. Short-break line
  - J. Long-break line
  - K. Phantom line
  - L. Stitch line
  - M. Chain line
  - N. Cylindrical break/conventional break lines
- V. List and Describe the Different Views Found on a Drawing
  - A. One view
    - 1. Sphere
    - 2. Plate
  - B. Two view
    - 1. Cylinder
    - 2. Rectangle
  - C. Three view
    - 1. Pyramids
    - 2. Multi-view projection
- VI. List and Apply the Three Primary Planes of Projection
  - A. Frontal projection plane
  - B. Profile projection plane
    - 1. Right side
    - 2. Left side
  - C. Horizontal projection plane
- VII. List and Apply the Six Principal Views
  - A. Front view
  - B. Rear view
  - C. Right side view
  - D. Left side view
  - E. Top view
  - F. Bottom view
- VIII. List and Apply Auxiliary Views
  - A. Surfaces needing auxiliary views
    - 1. Inclined surfaces

    - 2. Oblique surfaces
  - B. Primary auxiliary views
  - C. Secondary auxiliary views
  - D. To generate an auxiliary view
    - 1. Folding-line method
    - 2. Reference-plane method
  - E. Classifications of auxiliary views
    - 1. Depth auxiliary views
    - 2. Height auxiliary views
    - 3. Width auxiliary views
  - F. Dihedral angles
  - G. Partial auxiliary views
  - H. Half auxiliary views
  - I. Auxiliary sections
  - J. Basic four uses of auxiliary views
    - 1. True length of line
    - 2. Point view of line
    - 3. Edge view of plane
    - 4. True size of plane
- IX. List and Apply Sectional Views
  - A. Need for sectional views
  - B. Cutting plane
    - 1. Direction
    - 2. Labels
    - 3. Alternate styles
  - C. Section lining
    - 1. Techniques
    - 2. Symbols
  - D. Types of sectional views
    - 1. Full section
    - 2. Half/partial section
    - 3. Broken-out section
    - 4. Revolved section
    - 5. Removed section
    - 6. Offset section
    - 7. Aligned section
    - 8. Auxiliary section
    - 9. Partial section

Name______________________________ Date________________

TLD-C1
Interpret and Understand Basic Layout/Types of Drawings
Self-Assessment

1. Who is the ANSI?

2. Who is the ISO?

3. Identify three sheet size layouts.

4. Identify four forms of lettering arrangements.

5. What is multi-view projection?

6. What is perspective or central projection?

7. What is oblique projection?

8. What is axonometric projection?

9. What is the main part of a drawing?

10. Name five components in a title block.

11. Name four components in a bill of materials.

12. Identify and illustrate six types of lines that can be found on a drawing.

13. What is a one view drawing?

14. What is a two view drawing?

15. What is a three view drawing?

16. Identify and describe the three primary planes of projection.

17. Name the six principle views.

18. What are auxiliary views?

19. What surfaces need auxiliary views?

20. What is a primary auxiliary view?

21. What is a secondary auxiliary view?

22. Name two methods for generating auxiliary views.

23. Name three classifications for auxiliary views.

24. What is a dihedral angle?

25. What are partial auxiliary views?

26. What are half auxiliary views?

27. **What is an auxiliary section?**

28. **Name four uses for auxiliary views.**

29. **What are sectional views?**

30. **What are cutting planes?**

31. **Identify two section lining techniques.**

32. **Identify and illustrate five section lining symbols.**

33. **What is a full section?**

34. **What is a half / partial section?**

35. **What are broken-out sections?**

36. How are revolved sections used on drawings?

37. How are removed sections used on drawings?

38. What are off-set sections?

39. What are aligned sections?

40. What is the purpose of an auxiliary section?

TOOL & DIE and EDM SERIES

MASTER Technical Module No. TLD-C2

Subject: **Tool & Die and EDM** **Time: 8 Hrs.**

Duty: **Interpret Engineering Drawings and Related Documents**
Task: Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances

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Objective(s):

Upon completion of this unit the student will be able to:
a. Distinguish between general and specific notes;
b. Interpret and apply general and specific notes;
c. Determine and apply dimensions on a drawing;
d. Identify basic symbols and abbreviations found on a drawing;
e. Identify tolerances or limits on a drawing; and,
f. Identify ANSI limits and fits.

Instructional Materials:

MASTER Handout (TLD-C2-HO)
MASTER Self-Assessment

References:

Technical Drawing, Fredricke Giesecke, Alva Mitchell, Henry Cecil Spencer, Ivan Leroy Hill, John Thomas Dygdon, and James E. Novack, Macmillan, Latest Edition

Basic Blueprint Reading, Pamela Smith, Developed by Industrial Services Staff, Research and Curriculum Unit, Mississippi State University for Division of Vocational - Technical Education, Mississippi State Department of Education, Latest Edition

Technical Drawing, David L. Goetsch, John A. Nelson, and William S. Chalk, Delmar Publishing Inc., Latest Edition

Mechanical Drafting, David Madsen, Terence M. Schumaker and Susan A. Stewart, Delmar Publishing Inc., Latest Edition

Engineering Graphics, Fredrick E. Giesecke, Alva Michell, Henry Cecil Spencer, Ivan Leroy Hill, Robert Olin Loving, John Thomas Dygdon, James E. Novack, Macmillan Publishing Co., Latest Edition

Engineering Drawing and Design, Cecil Jensen, Jay Helsel, and Dennis Short, Glencoe, McGraw-Hill, Latest Edition (textbook and CD-ROM)

Machinery's Handbook, Erik Oberg, Franklin D. Liones, and Holbrook L. Horton, Industrial Press, Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:
TLD-C1 "Interpret and Understand Basic Layout/Types of Drawings"

Introduction:

The blueprint is the universal language of industry in all countries. While systems of measurements and drafting techniques vary between different countries, we are still striving for global standardization. The tool maker, by interpreting, reviewing, and applying the notes, dimensions, and tolerances properly, could produce identical parts and mechanisms, even though they worked in different countries and spoke different languages. The blueprint forms a foundation for the manufacturing and production of interchangeable parts, as well as, interchangeable workforces in a variety of countries.

Presentation Outline:

I. Distinguish Between General and Specific Notes
    A. General notes
    B. Specific notes/local notes
II. Interpret and Apply General and Specific Notes
    A. General notes applied
        1. Title strip/title block
        2. Parts list/bill of material
    B. Interpret general notes
        1. Including material
        2. General tolerances
        3. Heat treatment
        4. Pattern information
        5. Processes of manufacture
        6. Requirements of the product
    C. Interpret specific notes
        1. Apply to specific operations
        2. Apply to specific processes of manufacture
        3. Apply to the requirements of the product
III. Determine and Apply Dimensions on a Drawing
    A. Identify organizations that determine dimension standards
        1. American National Standards Institutes (ANSI)
        2. International Standards Organization (ISO)
    B. Determine dimensions on a drawing
        1. Size dimensions

        2. Location dimensions
    C. Applying dimensions on a drawing
        1. Scale of drawing
        2. Techniques of dimensioning
        3. Placement of dimensions
        4. Choice of dimensions
        5. Types of lines used in the dimensioning process
        6. Arrowheads used on drawings
        7. Leaders used on drawings
        8. Dimensioning systems
            a. Fractional
            b. Decimal
            c. Metric
            d. Combination dimensioning
        9. Dimension figures
        10. Direction of dimension figures
            a. Unidirectional system
            b. Aligned system
        11. Dimensioning angles
        12. Dimensioning arcs
        13. Dimensioning fillets and rounds
        14. Identify surfaces to be machined
        15. Contour dimensioning
        16. Dimensioning of curves
        17. Dimensioning of rounded-end shapes
        18. Dimensioning of threads
        19. Dimensioning of tapers
        20. Dimensioning of chamfers
        21. Dimensioning shaft centers
        22. Dimensioning keyways
        23. Dimensioning knurls
            a. Diamond
            b. Straight
        24. Dimensioning along curved surfaces
        25. Tabular dimensions
        26. Dimensioning standards
        27. Coordinate dimensioning
IV. Identify Basic Symbols and Abbreviations Found on a Drawing
    A. Traditional terms used to describe various shapes, processes, and size
    B. Identify abbreviations used to describe various shapes, processes, and size
    C. Identify a variety of dimensioning symbols used to replace traditional terms and abbreviations
V. Identify Tolerances or Limits on a Drawing
    A. Identify tolerances or limits

        1. Nominal size
        2. Basic size or dimension
        3. Actual size
        4. Tolerance
        5. Limits
        6. Allowance
    B. Methods of expressing tolerances
        1. General tolerances
        2. Limit dimensioning
        3. Plus and minus dimensioning
            a. Unilateral system
            b. Bilateral system
        4. Single-limit dimensioning
        5. Angular tolerances

VI. Identify ANSI Limits and Fits
    A. Fits between mating parts
        1. Clearance fit
        2. Interference fit
        3. Transition fit
        4. Line fit
    B. Limits and fits for cylindrical parts
        1. Running or sliding clearance fits
        2. Locational clearance fits
        3. Transition clearance interference fits
        4. Locational interference fits
        5. Force or shrink fits

Practical Application:

Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-C3) dealing with using and applying Geometric Dimensioning and Tolerancing (GD&T).

TLD-C2-HO
Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances
Attachment 1: **MASTER** Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Distinguish between general and specific notes;
b. Interpret and apply general and specific notes;
c. Determine and apply dimensions on a drawing;
d. Identify basic symbols and abbreviations found on a drawing;
e. Identify tolerances or limits on a drawing; and,
f. Identify ANSI limits and fits.

Module Outline:

I. Distinguish Between General and Specific Notes
    A. General notes
    B. Specific notes/local notes
II. Interpret and Apply General and Specific Notes
    A. General notes applied
        1. Title strip/title block
        2. Parts list/bill of material
    B. Interpret general notes
        1. Including material
        2. General tolerances
        3. Heat treatment
        4. Pattern information
        5. Processes of manufacture
        6. Requirements of the product
    C. Interpret specific notes
        1. Apply to specific operations
        2. Apply to specific processes of manufacture
        3. Apply to the requirements of the product
III. Determine and Apply Dimensions on a Drawing
    A. Identify organizations that determine dimension standards
        1. American National Standards Institutes (ANSI)
        2. International Standards Organization (ISO)
    B. Determine dimensions on a drawing
        1. Size dimensions
        2. Location dimensions
    C. Applying dimensions on a drawing
        1. Scale of drawing
        2. Techniques of dimensioning

    3. Placement of dimensions
    4. Choice of dimensions
    5. Types of lines used in the dimensioning process
    6. Arrowheads used on drawings
    7. Leaders used on drawings
    8. Dimensioning systems
        a. Fractional
        b. Decimal
        c. Metric
        d. Combination dimensioning
    9. Dimension figures
    10. Direction of dimension figures
        a. Unidirectional system
        b. Aligned system
    11. Dimensioning angles
    12. Dimensioning arcs
    13. Dimensioning fillets and rounds
    14. Identify surfaces to be machined
    15. Contour dimensioning
    16. Dimensioning of curves
    17. Dimensioning of rounded-end shapes
    18. Dimensioning of threads
    19. Dimensioning of tapers
    20. Dimensioning of chamfers
    21. Dimensioning shaft centers
    22. Dimensioning keyways
    23. Dimensioning knurls
        a. Diamond
        b. Straight
    24. Dimensioning along curved surfaces
    25. Tabular dimensions
    26. Dimensioning standards
    27. Coordinate dimensioning

IV. Identify Basic Symbols and Abbreviations Found on a Drawing
  A. Traditional terms used to describe various shapes, processes, and size
  B. Identify abbreviations used to describe various shapes, processes, and size
  C. Identify a variety of dimensioning symbols used to replace traditional terms and abbreviations

V. Identify Tolerances or Limits on a Drawing
  A. Identify tolerances or limits
    1. Nominal size
    2. Basic size or dimension
    3. Actual size
    4. Tolerance

    5. Limits
    6. Allowance
- B. Methods of expressing tolerances
    1. General tolerances
    2. Limit dimensioning
    3. Plus and minus dimensioning
        a. Unilateral system
        b. Bilateral system
    4. Single-limit dimensioning
    5. Angular tolerances

VI. Identify ANSI Limits and Fits
- A. Fits between mating parts
    1. Clearance fit
    2. Interference fit
    3. Transition fit
    4. Line fit
- B. Limits and fits for cylindrical parts
    1. Running or sliding clearance fits
    2. Locational clearance fits
    3. Transition clearance interference fits
    4. Locational interference fits
    5. Force or shrink fits

Name____________________________ Date________________

TLD-C2
Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances
Self-Assessment

1. What are general notes?

2. What are specific or local notes?

3. Name two places where general notes will appear on a drawing.

4. Name four categories that general notes supply information.

5. Name two specific or local notes.

6. Identify two organizations that determine dimension standards.

7. Name two important functions that dimensions serve on a drawing.

8. Name three considerations to dimension.

9. Identify three types of lines that can be used to dimension.

10. What is the length and width of an arrowhead?

11. Identify the parts of a leader.

12. Name three types of dimensioning systems.

13. Identify three specifications for dimensioning figures.

14. Name two systems of reading direction for dimensions.

15. Name two specifications for dimensioning angles.

16. Identify two specifications for dimensioning arcs.

17. Name two specifications for dimensioning fillets and rounds.

18. What is used to represent surfaces to be machined?

19. What is contour dimensioning?

20. Name two specifications for dimensioning curves.

21. Name two methods for dimensioning round-end shapes.

22. What information would be contained in a thread dimension.

23. What information would be needed to dimension a taper?

24. What information would be necessary to dimension a chamfer?

25. What information would be needed to dimension a shaft center?

26. Name two methods for dimensioning keyways.

27. Name two specifications for dimensioning knurls.

28. Name two specifications for dimensioning along curved surfaces.

29. What is tabular dimensions?

30. Where could one go to get dimensioning standards?

31. What is coordinate dimensioning?

32. Name five terms used to describe various shapes, processes, and size.

33. Name five abbreviations used to describe various shapes, processes, and size.

34. Illustrate five symbols used to replace traditional terms and abbreviations.

35. What is nominal size?

36. What is basic size or dimension?

37. What does actual size refer to?

38. What specifically does tolerance mean?

39. What are limits?

40. What does allowance mean?

41. Name three methods of expressing tolerances.

42. Name three general types of fit between parts.

43. Name three types of fits for cylindrical parts.

TOOL & DIE and EDM SERIES

MASTER Technical Module No. TLD-C3

Subject: **Tool & Die and EDM** **Time: 10 Hrs.**

Duty: **Interpret Engineering Drawings and Related Documents**
Task: Use and Apply Geometric Dimensioning and Tolerancing (GD&T)

Objective(s):

Upon completion of this unit the student will be able to:

a. Distinguish between conventional and geometric dimensioning and tolerancing;
b. Explain and use geometric positional tolerancing and symbols;
c. Explain and use tolerances of form and symbols;
d. Explain and use the feature control symbol; and,
e. Explain and use modifiers in geometric dimensioning and tolerancing.

Instructional Materials:

MASTER Handout (TLD-C3-HO)
MASTER Self-Assessment

References:

Technical Drawing, Fredricke Giesecke, Alva Mitchell, Henry Cecil Spencer, Ivan Leroy Hill, John Thomas Dygdon, and James E. Novack, Macmillan Publishing, Latest Edition

Geometric Dimensioning and Tolerancing, David A. Madsen, Goodheart-Willcox Co. Inc., Latest Edition

Geometric Dimensioning and Tolerancing for Engineering and Manufacturing Technology, Cecil Jensen, Delmar Publishing Inc., Latest Edition

Design Dimensioning and Tolerancing, Bruce A. Wilson, Goodheart-Willcox Co. Inc., Latest Edition

Engineering Graphics, Fredrick E. Giesecke, Alva Michell, Henry Cecil Spencer, Ivan Leroy Hill, Robert Olin Loving, John Thomas Dygdon, James E. Novack, Macmillan Publishing Co., Latest Edition

Geometric Dimensioning and Tolerancing: A Self-Study Workbook, Alex Krucikowski, Effective Training Inc., Latest Edition

Fundamentals of Geometric Dimensioning and Tolerancing, Alex Krucikowski, Delmar Publishing Inc., Latest Edition

Instruction To Geometric Tolerancing, Beckwith and Associates, Inc., American Machinist Beckwith Training, Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:

- **TLD-C1** "Interpret and Understand Basic Layout/Types of Drawings"
- **TLD-C2** "Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances"

Introduction:

In this highly competitive, industrial world in which we live, every possible method should be taken to improve efficiency and reduce product cost. By understanding and applying geometric dimensioning and tolerancing to current designs and products this goal can be achieved. Geometric dimensioning and tolerancing is an aid to better communication of dimensioning standards and design philosophy to provide liberal tolerances that can gain substantial savings in a company's tool and die making operation expenses.

Presentation Outline:

I. Distinguish Between Conventional and Geometric Dimensioning and Tolerancing
    A. General/conventional tolerancing
        1. Definitions of general/conventional tolerancing
            a. Dimension
            b. Reference dimension
            c. Feature
            d. Feature of size
            e. Actual size
            f. Stock size
        2. Maximum material condition
        3. Least material condition
        4. Basic fits
        5. Clearance fit
        6. Allowance
        7. Clearance
        8. Force fit
    B. Geometric dimensioning and tolerancing
        1. Definition of geometric dimensioning and tolerancing
        2. Dimensioning rules
        3. Dimensioning units
II. Explain and Use Geometric Positional Tolerancing and Symbols

- A. Explain positional / location tolerances
- B. Identify and use geometric position tolerancing symbols
  - 1. Position
  - 2. Concentricity
  - 3. Symmetry

III. Explain and Use Tolerances of Form Symbols
- A. Explain form tolerances
- B. Identify and use tolerances of form symbols
  - 1. Straightness
  - 2. Flatness
  - 3. Circularity
  - 4. Cylindrical

IV. Explain and Use Profile Tolerances
- A. Explain profile tolerance
- B. Identify and use profile tolerance symbols
  - 1. Profile of a line
  - 2. Profile of a surface
  - 3. Profile of an arc
  - 4. Profile of irregular curves
  - 5. Profile of coplanar surfaces

V. Explain and Use Tolerances of Orientation
- A. Explain orientation tolerances
- B. Identify and use orientation tolerance symbols
  - 1. Parallelism
  - 2. Perpendicularity
  - 3. Angularity

VI. Explain and Use Runout Tolerances
- A. Explain runouts
  - 1. Circular
  - 2. Total
- B. Identify and use runout tolerances symbols
  - 1. Circular
  - 2. Total

VII. Explain and Use Modifiers in Geometric Dimensioning and Tolerancing
- A. Maximum material condition (MMC)
- B. Regardless of feature size (RFS)
- C. Least material condition (LMC)
- D. Datum feature symbol
- E. Datum reference frame concept
  - 1. Primary datum plane
  - 2. Secondary datum plane
  - 3. Tertiary datum plane
- F. Datum target symbol
  - 1. Target point
  - 2. Target line

    - 3. Target area
- VIII. Explain and Use the Feature Control Frame
  - A. Explain feature control frame
  - B. Explain the compartments of a feature control frame
    - 1. Geometric characteristic symbol
    - 2. Geometric tolerance
    - 3. Zone descriptor
    - 4. Material condition symbol
    - 5. Primary datum reference
    - 6. Secondary datum reference
    - 7. Tertiary datum reference
- IX. Additional Supplementary Modifying Symbols
  - A. Explain and use additional modifying symbols.
    - 1. Diameter
    - 2. Radius R
    - 3. Reference ( )
    - 4. Counterbore/spotface L/
    - 5. Square □
    - 6. Dimension origin O
    - 7. Slope
    - 8. Projected tolerance zone
    - 9. Spherical diameter
    - 10. Spherical radius
    - 11. Arc length
    - 12. Counter sink
    - 13. Depth
    - 14. Conical taper
    - 15. Place, times, or by
    - 16. Basic dimension

Practical Application:

Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-C4) dealing with demonstrating traditional mechanical drafting and sketching techniques.

TLD-C3-HO
Use and Apply Geometric Dimensioning and Tolerancing (GD&T)
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

- a. Distinguish between conventional and geometric dimensioning and tolerancing;
- b. Explain and use geometric positional tolerancing and symbols;
- c. Explain and use tolerances of form and symbols;
- d. Explain and use the feature control symbol; and,
- e. Explain and use modifiers in geometric dimensioning and tolerancing.

Module Outline:

- I. Distinguish Between Conventional and Geometric Dimensioning and Tolerancing
  - A. General/conventional tolerancing
    - 1. Definitions of general/conventional tolerancing
      - a. Dimension
      - b. Reference dimension
      - c. Feature
      - d. Feature of size
      - e. Actual size
      - f. Stock size
    - 2. Maximum material condition
    - 3. Least material condition
    - 4. Basic fits
    - 5. Clearance fit
    - 6. Allowance
    - 7. Clearance
    - 8. Force fit
  - B. Geometric dimensioning and tolerancing
    - 1. Definition of geometric dimensioning and tolerancing
    - 2. Dimensioning rules
    - 3. Dimensioning units
- II. Explain and Use Geometric Positional Tolerancing and Symbols
  - A. Explain positional / location tolerances
  - B. Identify and use geometric position tolerancing symbols
    - 1. Position
    - 2. Concentricity
    - 3. Symmetry
- III. Explain and Use Tolerances of Form Symbols
  - A. Explain form tolerances

  - B. Identify and use tolerances of form symbols
    - 1. Straightness
    - 2. Flatness
    - 3. Circularity
    - 4. Cylindrical
- IV. Explain and Use Profile Tolerances
  - A. Explain profile tolerance
  - B. Identify and use profile tolerance symbols
    - 1. Profile of a line
    - 2. Profile of a surface
    - 3. Profile of an arc
    - 4. Profile of irregular curves
    - 5. Profile of coplanar surfaces
- V. Explain and Use Tolerances of Orientation
  - A. Explain orientation tolerances
  - B. Identify and use orientation tolerance symbols
    - 1. Parallelism
    - 2. Perpendicularity
    - 3. Angularity
- VI. Explain and Use Runout Tolerances
  - A. Explain runouts
    - 1. Circular
    - 2. Total
  - B. Identify and use runout tolerances symbols
    - 1. Circular
    - 2. Total
- VII. Explain and Use Modifiers in Geometric Dimensioning and Tolerancing
  - A. Maximum material condition (MMC)
  - B. Regardless of feature size (RFS)
  - C. Least material condition (LMC)
  - D. Datum feature symbol
  - E. Datum reference frame concept
    - 1. Primary datum plane
    - 2. Secondary datum plane
    - 3. Tertiary datum plane
  - F. Datum target symbol
    - 1. Target point
    - 2. Target line
    - 3. Target area
- VIII. Explain and Use the Feature Control Frame
  - A. Explain feature control frame
  - B. Explain the compartments of a feature control frame
    - 1. Geometric characteristic symbol
    - 2. Geometric tolerance
    - 3. Zone descriptor

        4. Material condition symbol
        5. Primary datum reference
        6. Secondary datum reference
        7. Tertiary datum reference

IX. Additional Supplementary Modifying Symbols
    A. Explain and use additional modifying symbols.
        1. Diameter
        2. Radius R
        3. Reference ( )
        4. Counterbore/spotface L/
        5. Square □
        6. Dimension origin O
        7. Slope
        8. Projected tolerance zone
        9. Spherical diameter
        10. Spherical radius
        11. Arc length
        12. Counter sink
        13. Depth
        14. Conical taper
        15. Place, times, or by
        16. Basic dimension

Name______________________ Date____________

TLD-C3
Use and Apply Geometric Dimensioning and Tolerancing (GD&T)
Self-Assessment

1. What is conventional tolerancing?

2. Name three terms associated with conventional tolerancing.

3. Describe the term maximum material condition.

4. Define the term least material condition.

5. Identify basic fits of mating parts.

6. Describe clearance fit.

7. What is allowance?

8. Define clearance.

9. What is force fit?

10. Define geometric dimensioning and tolerance.

11. List three general rules for dimensioning and tolerancing.

12. List two general units used for dimensioning and tolerancing.

13. What is positional tolerancing?

14. Define location tolerancing.

15. Represent two position / location tolerancing symbols.

16. Define form tolerances.

17. Represent three form tolerancing symbols.

18. What is profile tolerancing?

19. Represent three profile tolerancing symbols.

20. Define orientation tolerances.

21. Represent two orientation tolerancing symbols.

22. What are runout tolerances?

23. Define circular runouts.

24. Define total runouts.

25. Represent two runout tolerancing symbols.

26. What are modifiers in geometric dimensioning and tolerancing.

27. Represent two modifiers in geometric dimensioning and tolerancing.

28. Define datums as used in geometric dimensioning and tolerancing.

29. Describe the datum reference frame concept.

30. Name three datum planes.

31. What are datum target?

32. Represent three datum target symbols.

33. Define feature control frame.

34. Describe the various compartments of a feature control frame.

35. Represent a feature control frame with symbols for each compartment.

36. List other additional modifiers used in geometric dimensioning and tolerancing.

37. Represent five additional modifying symbols used in geometric dimensioning and tolerancing.

TOOL & DIE and EDM SERIES

MASTER Technical Module No. TLD-C4

Subject: **Tool & Die and EDM** **Time: 24 Hrs.**

Duty: **Interpret Engineering Drawings and Related Documents**
Task: Demonstrate Traditional Mechanical Drafting and Sketching Techniques

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Objective(s):

Upon completion of this unit the student will be able to:

a. Demonstrate use of drafting machine;
b. Demonstrate use of drafting instruments;
c. Demonstrate drafting techniques used to create basic geometric elements;
d. Demonstrate sketching techniques;
e. Demonstrate isometric sketching;
f. Demonstrate oblique sketching; and,
g. Demonstrate perspective sketching.

Instructional Materials:

MASTER Handout (TLD-C4-HO)
MASTER Laboratory Exercise (TLD-C4-LE)
MASTER Self-Assessment

References:

Technical Drawing, Fredricke Giesecke, Alva Mitchell, Henry Cecil Spencer, Ivan Leroy Hill, John Thomas Dygdon, and James E. Novack, Macmillan Publishing Co., Latest Edition

Technical Drawing, David L. Goetsch, John A. Nelson, and William S. Chalk, Delmar Publishing Inc., Latest Edition

Mechanical Drafting, David Madsen, Terence M. Schumaker and Susan A. Stewart, Delmar Publishing Inc., Latest Edition

Engineering Graphics, Fredricke E. Giesecke, Alva Mitchell, Henry Cecil Spencer, Ivan Leroy Hill, Robert Olin Loving, John Thomas Dygdon, James E. Novack, Macmillan Publishing Co., Latest Edition

Engineering Drawing and Design, Cecil Jensen and Jay Helsel, Glencoe, McGraw-Hill, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:

TLD-G1	"Interpret and Understand Basic Layout/Types of Drawings"
TLD-G2	"Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances"
TLD-G3	"Use and Apply Geometric Dimensioning and Tolerancing (GD&T)"

Introduction:

The graphic representation of real thing and ideas can be developed along two lines of thought and purpose, artistic and technical. The earlier technical drawings go back to the Romans but it was not until the fifteenth and sixteenth century that mechanical drawings were generated. This brought about the development of the scribe-type compass which gave way to the compass with graphite lead shortly after graphite pencils were developed. The tool and die maker of today must use many technical devices to accomplish their goals. One such technical device is the drafting board and machine, another is the drafting instruments and equipment.

Presentation Outline:

I. Demonstrate Use of Drafting Machine
  A. Types of drafting machines
    1. Elbow drafting machines
      a. Controlling head
      b. Vernier
    2. Track drafting machines
      a. Controlling head
      b. Vernier
II. Demonstrate Use of Drafting Instruments
  A. Drawing pencil types
    1. Drawing pencil
      a. Grade
      b. Sharpening
    2. Mechanical pencil
      a. Grade
      b. Sharpening
    3. Thin-lead mechanical pencil
      a. Grade
      b. Lead diameter
  B. Types of erasers
    1. Pink pearl

  2. Mars - plastiz
  3. Artgum
  4. Electric erasing machine
C. Erasing shield
D. Dusting brush
E. Types of triangles
  1. 45° triangle
  2. 30° x 60° triangle
  3. Adjustable triangle
F. Protractor
G. Types of scales
  1. Metric scale
  2. Engineers' scale
  3. Mechanical engineers' scale
  4. Decimal scale
  5. Architects' scale
  6. Combination scale
H. Drawing instruments
  1. Compass
    a. Giant bow compass
    b. Beam attachment
  2. Beam compass/trammel
  3. Dividers
I. Irregular/french curve
J. Templets
  1. Circle
  2. Ellipse
  3. Chemical
  4. Electrical
  5. Architectural
  6. Mechanical
K. Lettering guide
L. Calculator
M. Drafting tape
N. Pencil lead sharpening devices
  1. Lead pointer
  2. Sandpaper pad
O. Drafting board table
P. Drafting paper/detail paper
Q. Tracing papers kinds
  1. Treated with oils, waxes, and similar substances (vellums)
  2. Non-treated papers
R. Tracing cloth
S. Polyester film

III. Demonstrate Drafting Techniques to Create Basic Geometric Elements

- A. Perform drafting techniques necessary to bisect a line or a circular arc
- B. Perform drafting techniques necessary to bisect an angle and to transfer an angle
- C. Perform drafting techniques necessary to construct a line parallel to a given line at a given distance
- D. Perform drafting techniques necessary to divide a line into equal or proportional parts
- E. Perform drafting techniques necessary to construct a triangle with the length of the sides given
- F. Perform drafting techniques necessary to inscribe a circle in a triangle
- G. Perform drafting techniques necessary to construct a right triangle with hypotenuse and one side given
- H. Perform drafting techniques necessary to construct a line through a point and perpendicular to a given line at the prescribed point and from a point off the given line
- I. Perform drafting techniques necessary to construct a square with a side given
- J. Perform drafting techniques necessary to inscribe a regular pentagon in a given circle
- K. Perform drafting techniques necessary to inscribe and circumscribe a hexagon on a given circle
- L. Perform drafting techniques necessary to inscribe an octagon in a given square
- M. Perform drafting techniques necessary to construct a circle through three given points not in a straight line
- N. Perform drafting techniques necessary to construct a circle of a given size tangent to a given line and passing through a given point
- O. Perform drafting techniques necessary to construct a circle tangent to a given line at a prescribed point on that line and passing through a given point not on that line
- P. Perform drafting techniques necessary to construct a circle of a given size tangent to a given circle and passing through a given point
- Q. Perform drafting techniques necessary to construct an arc of a given size tangent to two given intersecting lines at acute or obtuse angles
- R. Perform drafting techniques necessary to construct a given size circle tangent to two given circles
- S. Perform drafting techniques necessary to construct an ellipse using the concentric circle method with major and minor diameters given
- T. Perform drafting techniques necessary to construct an approximate ellipse with major and minor diameters given

IV. Demonstrate Sketching Techniques
  - A. Horizontal lines
  - B. Vertical lines
  - C. Inclined lines
  - D. Circles

- E. Arcs
- F. Ellipses

V. Demonstrate Isometric Sketching
- A. Box construction technique
- B. Blocking recesses and projections
- C. Dim all construction lines
- D. Heavy in all final lines

VI. Demonstrate Oblique Sketching
- A. Block in front view
- B. Sketch receding lines
- C. Dim all construction lines
- D. Heavy in all final lines

VII. Demonstrate Perspective Sketching
- A. One-point perspective
  - 1. Sketch the true front view and select vanishing point
  - 2. Sketch receding lines to vanishing point
  - 3. Estimate the depth
  - 4. Dim all construction lines
  - 5. Heavy in all final lines
- B. Two-point perspective
  - 1. Sketch the front corner of view in true height and locate two vanishing points on a horizontal line
  - 2. Estimate depth and width and sketch enclosing box
  - 3. Block in all details
  - 4. Dim all construction lines
  - 5. Heavy in all final lines
  - 6. Make contour lines thicker and inside lines thinner

Practical Application:

Student should be assigned several drawing projects with various drafting machines, instruments, techniques. Geometry and various sketching skills are required at various degrees of accuracy to generate and complete the assigned task.

Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this lesson along with successful completion of traditional mechanical drafting skills to complete assigned exercises.

Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-C5) dealing with understanding and using quality systems.

TLD-C4-HO
Demonstrate Traditional Mechanical Drafting and Sketching Techniques
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Demonstrate use of drafting machine;
b. Demonstrate use of drafting instruments;
c. Demonstrate drafting techniques used to create basic geometric elements;
d. Demonstrate sketching techniques;
e. Demonstrate isometric sketching;
f. Demonstrate oblique sketching; and,
g. Demonstrate perspective sketching.

Module Outline:

I. Demonstrate Use of Drafting Machine
    A. Types of drafting machines
        1. Elbow drafting machines
            a. Controlling head
            b. Vernier
        2. Track drafting machines
            a. Controlling head
            b. Vernier
II. Demonstrate Use of Drafting Instruments
    A. Drawing pencil types
        1. Drawing pencil
            a. Grade
            b. Sharpening
        2. Mechanical pencil
            a. Grade
            b. Sharpening
        3. Thin-lead mechanical pencil
            a. Grade
            b. Lead diameter
    B. Types of erasers
        1. Pink pearl
        2. Mars - plastiz
        3. Artgum
        4. Electric erasing machine
    C. Erasing shield
    D. Dusting brush

E. Types of triangles
  1. 45° triangle
  2. 30° x 60° triangle
  3. Adjustable triangle
F. Protractor
G. Types of scales
  1. Metric scale
  2. Engineers' scale
  3. Mechanical engineers' scale
  4. Decimal scale
  5. Architects' scale
  6. Combination scale
H. Drawing instruments
  1. Compass
    a. Giant bow compass
    b. Beam attachment
  2. Beam compass/trammel
  3. Dividers
I. Irregular/french curve
J. Templets
  1. Circle
  2. Ellipse
  3. Chemical
  4. Electrical
  5. Architectural
  6. Mechanical
K. Lettering guide
L. Calculator
M. Drafting tape
N. Pencil lead sharpening devices
  1. Lead pointer
  2. Sandpaper pad
O. Drafting board table
P. Drafting paper/detail paper
Q. Tracing papers kinds
  1. Treated with oils, waxes, and similar substances (vellums)
  2. Non-treated papers
R. Tracing cloth
S. Polyester film

III. Demonstrate Drafting Techniques to Create Basic Geometric Elements
  A. Perform drafting techniques necessary to bisect a line or a circular arc
  B. Perform drafting techniques necessary to bisect an angle and to transfer an angle
  C. Perform drafting techniques necessary to construct a line parallel to a given line at a given distance

D. Perform drafting techniques necessary to divide a line into equal or proportional parts
E. Perform drafting techniques necessary to construct a triangle with the length of the sides given
F. Perform drafting techniques necessary to inscribe a circle in a triangle
G. Perform drafting techniques necessary to construct a right triangle with hypotenuse and one side given
H. Perform drafting techniques necessary to construct a line through a point and perpendicular to a given line at the prescribed point and from a point off the given line
I. Perform drafting techniques necessary to construct a square with a side given
J. Perform drafting techniques necessary to inscribe a regular pentagon in a given circle
K. Perform drafting techniques necessary to inscribe and circumscribe a hexagon on a given circle
L. Perform drafting techniques necessary to inscribe an octagon in a given square
M. Perform drafting techniques necessary to construct a circle through three given points not in a straight line
N. Perform drafting techniques necessary to construct a circle of a given size tangent to a given line and passing through a given point
O. Perform drafting techniques necessary to construct a circle tangent to a given line at a prescribed point on that line and passing through a given point not on that line
P. Perform drafting techniques necessary to construct a circle of a given size tangent to a given circle and passing through a given point
Q. Perform drafting techniques necessary to construct an arc of a given size tangent to two given intersecting lines at acute or obtuse angles
R. Perform drafting techniques necessary to construct a given size circle tangent to two given circles
S. Perform drafting techniques necessary to construct an ellipse using the concentric circle method with major and minor diameters given
T. Perform drafting techniques necessary to construct an approximate ellipse with major and minor diameters given

IV. Demonstrate Sketching Techniques
A. Horizontal lines
B. Vertical lines
C. Inclined lines
D. Circles
E. Arcs
F. Ellipses

V. Demonstrate Isometric Sketching
A. Box construction technique
B. Blocking recesses and projections

- C. Dim all construction lines
- D. Heavy in all final lines

VI. Demonstrate Oblique Sketching
- A. Block in front view
- B. Sketch receding lines
- C. Dim all construction lines
- D. Heavy in all final lines

VII. Demonstrate Perspective Sketching
- A. One-point perspective
  1. Sketch the true front view and select vanishing point
  2. Sketch receding lines to vanishing point
  3. Estimate the depth
  4. Dim all construction lines
  5. Heavy in all final lines
- B. Two-point perspective
  1. Sketch the front corner of view in true height and locate two vanishing points on a horizontal line
  2. Estimate depth and width and sketch enclosing box
  3. Block in all details
  4. Dim all construction lines
  5. Heavy in all final lines
  6. Make contour lines thicker and inside lines thinner

TLD-C4-LE
Demonstrate Traditional Mechanical Drafting and Sketching Techniques
Attachment 2: MASTER Laboratory Exercise

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1. The instructor will:
   a. Demonstrate use of drafting machine;
   b. Demonstrate use of drafting instruments;
   c. Demonstrate drafting techniques to create basic geometric elements;
   d. Demonstrate sketching techniques, including:
      (1) Isometric sketching;
      (2) Oblique sketching; and,
      (3) One-point and two-point perspective sketching.

2. The student will:
   a. Demonstrate use of drafting machine;
   b. Demonstrate use of drafting instruments;
   c. Demonstrate drafting techniques to create basic geometric elements, which include:
      (1) Bisecting a line or a circular arc;
      (2) Bisecting an angle and to transfer an angle;
      (3) Constructing a line parallel to a given line at a given distance;
      (4) Dividing a line into equal or proportional parts;
      (5) Constructing a triangle with the length of the sides given;
      (6) Inscribing a circle in a triangle;
      (7) Constructing a right triangle with hypotenuse and one side given;
      (8) Constructing a line through a point and perpendicular to a given line at the prescribed point and from a point off the given line;
      (9) Constructing a square with a side given;
      (10) Inscribing a regular pentagon in a given circle;
      (11) Inscribing and circumscribing a hexagon on a given circle;
      (12) Inscribing an octagon in a given square;
      (13) Constructing a circle through three given points not in a straight line;
      (14) Constructing a circle of a given size tangent to a given line and passing through a given point;
      (15) Constructing a circle tangent to a given line at a prescribed point on that line and passing through a given point not on that line;
      (16) Constructing a circle of a given size tangent to a given circle and passing through a given point;

    - (17) Constructing an arc of a given size tangent to two given intersecting lines at acute or obtuse angles;
    - (18) Constructing a given size circle tangent to two given circles;
    - (19) Constructing an ellipse using the concentric circle method with major and minor diameters given;
    - (20) Construct an approximate ellipse with major and minor diameters given;
  - d. Demonstrate sketching techniques, including:
    - (1) Isometric sketching;
    - (2) Oblique sketching; and,
    - (3) One-point and two-point perspective sketching.

3. The instructor will grade the student's performance on the student's ability to:
  - a. Demonstrate use of drafting machine;
  - b. Demonstrate use of drafting instruments;
  - c. Demonstrate drafting techniques to create basic geometric elements, which include:
    - (1) Bisecting a line or a circular arc;
    - (2) Bisecting an angle and to transfer an angle;
    - (3) Constructing a line parallel to a given line at a given distance;
    - (4) Dividing a line into equal or proportional parts;
    - (5) Constructing a triangle with the length of the sides given;
    - (6) Inscribing a circle in a triangle;
    - (7) Constructing a right triangle with hypotenuse and one side given;
    - (8) Constructing a line through a point and perpendicular to a given line at the prescribed point and from a point off the given line;
    - (9) Constructing a square with a side given;
    - (10) Inscribing a regular pentagon in a given circle;
    - (11) Inscribing and circumscribing a hexagon on a given circle;
    - (12) Inscribing an octagon in a given square;
    - (13) Constructing a circle through three given points not in a straight line;
    - (14) Constructing a circle of a given size tangent to a given line and passing through a given point;
    - (15) Constructing a circle tangent to a given line at a prescribed point on that line and passing through a given point not on that line;
    - (16) Constructing a circle of a given size tangent to a given circle and passing through a given point;
    - (17) Constructing an arc of a given size tangent to two given intersecting lines at acute or obtuse angles;
    - (18) Constructing a given size circle tangent to two given circles;

(19) Constructing an ellipse using the concentric circle method with major and minor diameters given;
(20) Construct an approximate ellipse with major and minor diameters given;

d. Demonstrate sketching techniques, including:
(1) Isometric sketching;
(2) Oblique sketching; and,
(3) One-point and two-point perspective sketching.

Name____________________________ Date________________

TLD-C4
Demonstrate Traditional Mechanical Drafting and Sketching Techniques
Self-Assessment

1. Name two types of drafting machines.

2. What is a control head?

3. What is a vernier?

4. How does one read a vernier?

5. Name three types of pencils used in technical drawing.

6. List three grades of drafting pencils.

7. Describe two methods of sharpening drafting pencils.

8. Name two types of erasers used in technical drafting.

9. What is the primary function of an erasing shield?

10. How is the dusting brush used in technical drafting?

11. Name three types of triangles used in technical drafting.

12. Describe the use of a protractor in technical drafting.

13. Identify four types of scales used in technical drafting.

14. What is contained in a set of drawing instruments?

15. Define french/irregular curve and explain its' use.

16. Name four types of templets used in technical drafting?

17. Describe the use of a lettering guide in technical drafting.

18. Name the modern day device used in technical drafting which aids in mathematical computations.

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19. Identify and explain the use of the material used to hold technical drawings in place.

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20. What type of surface should one try to generate technical drawings on?

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21. Name the type of paper used to generate technical drawings.

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22. Identify two types of tracing paper used in technical drafting.

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23. Name the thin transparent muslin fabric sized with a starch compound or plastic to provide a good working surface for pencil or ink.

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24. Name the transparent film that is a superior drafting material. It is made by bonding a mat surface to one or both sides of a sheet or roll.

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____

25. Name four solid geometric shapes used in technical drafting.

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____

26. Describe a point as used in technical drafting.

28. Define what a line is in technical drafting.

29. What is a parallel line?

30. Define and explain perpendicular lines.

31. What does bisect mean in geometric construction?

32. Define a circle as used in technical drafting.

33. Describe a right angle as used in technical drafting.

34. What is an acute angle as used in geometric construction?

35. Define an obtuse angle as used in geometric construction.

36. Describe a complimentary angle as used in geometric construction.

37. What is a supplementary angle as used in geometric construction.

38. Define an equilateral triangle.

39. Describe an isosceles triangle.

40. What is a scalene triangle?

41. Define a right angle.

42. Name four quadrilaterals.

43. Identify four regular polygons.

44. Describe and explain concentric and eccentric circles.

45. What is circumference?

46. Define diameter of a circle.

47. Describe radius of a circle.

48. What does the term tangent mean as used in geometric construction?

49. Name two methods used to generate ellipse.

50. Describe sketching techniques for horizontal lines.

51. Describe sketching techniques for vertical lines.

52. Describe sketching techniques for inclined lines.

53. Describe sketching techniques for generating circles.

54. Describe sketching techniques for generating arcs.

55. Describe sketching techniques for generating ellipses.

56. List and define isometric sketching techniques.

57. Name and define oblique sketching techniques.

58. Identify one-point perspective sketching and explain this technique.

59. Identify two-point perspective sketching and explain this technique.

TOOL & DIE and EDM SERIES

MASTER Technical Module No. TLD-C5

Subject: **Tool & Die and EDM** **Time: 6 Hrs.**

Duty: **Interpret Engineering Drawings and Related Documents**
Task: Understand and Use Quality Systems

Objective(s):

Upon completion of this unit the student will be able to:
a. Understand and apply quality principles, including continuous improvement; and,
b. Document paper trails for part revisions.

Instructional Materials:

MASTER Handout (TLD-C5-HO)

References:

Student Preparation:

Introduction:

The ultimate goal of all technicians is to fabricate perfect parts and make absolute repairs. Unfortunately, we just can't get there from here. However, with the consistent application of quality controls *at every level*, we can get close.

Presentation Outline:

I. Understand and Apply Quality Principles, Including Continuous Improvement
  A. Tolerances as basic quality control
  B. The technician as the first line of excellence
  C. Specific systems
  These systems are diverse. You, as the instructor, must tailor this portion of the lecture to the system used in your circumstances.
  D. The inspector as guarantor
  E. The consumer: the ultimate judge of top quality

II. ISO 9000
    A. Purpose
    B. What is ISO 9000?
    C. How does is work?
    D. Where do the standards come from?
    E. Who uses this stuff, anyway?
III. Document Paper Trails for Part Revisions

Practical Application:

Due to the large number of quality assurance systems, the instructor must tailor the Self-Assessment to his own company.

Evaluation and/or Verification:

Students should successfully complete the Self-Assessment.

Summary:

Review the main lesson points and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-D1) dealing with physical properties of manufacturing materials.

TLD-C5-HO
Understand and Use Quality Systems
Attachment 1: **MASTER** Handout

Objective(s):

Upon completion of this unit the student will be able to:
- a. Understand and apply quality principles, including continuous improvement; and,
- b. Document paper trails for part revisions.

Module Outline:

- I. Understand and Apply Quality Principles, Including Continuous Improvement
  - A. Tolerances as basic quality control
  - B. The technician as the first line of excellence
  - C. Specific systems
    These systems are diverse. You, as the instructor, must tailor this portion of the lecture to the system used in your circumstances.
  - D. The inspector as guarantor
  - E. The consumer: the ultimate judge of top quality
- II. ISO 9000
  - A. Purpose
  - B. What is ISO 9000?
  - C. How does is work?
  - D. Where do the standards come from?
  - E. Who uses this stuff, anyway?
- III. Document Paper Trails for Part Revisions

TOOL AND DIE MAKER .... skilled workers who produce tools, dies, and special guiding and holding devices that are used in machining.

	Duties	← Tasks →												
A	Practice Safety	A-1 Follow safety manuals and all safety regulations/ requirements	A-2 Maintain safe equipment and machinery	A-3 Use safe operating procedures for hand and machine tools	A-4 Maintain a clean and safe work environment	A-5 Use safe material handling practices	A-6 Consult and apply MSDS for hazards of various materials							
B	Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Perform basic algebraic operations	B-3 Use basic geometric principles	B-4 Perform basic trigonometric functions	B-5 Use and apply Cartesian Coordinate System								
C	Interpret Engineering Drawings and Related Documents	C-1 Interpret and understand basic layout/types of drawings	C-2 Interpret, review, and apply blueprint notes, dimensions, and tolerances	C-3 Use and apply Geometric Dimensioning and Tolerancing (GD&T)	C-4 Demonstrate traditional mechanical drafting and sketching techniques	C-5 Understand and use quality systems								
D	Demonstrate Knowledge of Manufacturing Materials	D-1 Identify materials with desired properties	D-2 Identify materials and processes to produce a part	D-3 Discuss classification systems for metal										
E	Measure/ Inspect	E-1 Understand metrology terms	E-2 Select measurement tools	E-3 Measure with hand held instruments	E-4 Eliminate measurement variables	E-5 Measure/inspect using surface plate and accessories	E-6 Inspect using stationary equipment							
F	Demonstrate Knowledge of Manufacturing Processes	F-1 Discuss metal cutting and metal cutting tools	F-2 Operate metal saws	F-3 Operate drill presses and tooling	F-4 Operate engine and turret lathes and tooling	F-5 Operate vertical and horizontal mills and tooling	F-6 Operate precision grinders	F-7 Operate heat treating equipment and processes	F-8 Operate sheet metal equipment	F-9 Operate welding equipment and processes	F-10 Estimate time required/ cost to produce a part			
G	Use Computers	G-1 Use computer operating systems	G-2 Understand computer terminology	G-3 Use file management systems	G-4 Install and use software packages									
H	Perform CAD/ CAM and CNC Programming Tasks	H-1 Discuss fundamentals of CNC machines and controls	H-2 Program and operate CNC milling machine and machining center	H-3 Program and operate CNC lathe	H-4 Use Computer-Aided Drafting (CAD) system	H-5 Create 3-D solid models	H-6 Use Computer-Aided Manufacturing (CAM) system							
I	Perform Tool and Die Making Operations	I-1 Discuss basic types and functions of jigs and fixtures	I-2 Utilize concepts of jig and fixture design	I-3 Demonstrate understanding of different types of industrial dies	I-4 Utilize basic die theory	I-5 Utilize principles of die design	I-6 Perform tool and die repair	I-7 Demonstrate tool and die making skills						
J	Operate Electrical Discharge Machine (EDM)	J-1 Discuss fundamentals of EDM	J-2 Setup and operate conventional sinker EDM	J-3 Program, setup, and operate CNC sinker EDM and EDM drill	J-4 Program, setup, and operate CNC wire EDM									

TLD-D1

TOOL & DIE and EDM SERIES

MASTER Technical Module No. TLD-D1

Subject: **Tool & Die and EDM** **Time: 2 Hrs.**

Duty: **Demonstrate Knowledge of Manufacturing Materials**
Task: Identify Materials With Desired Properties

Objective(s):

Upon completion of this unit the student will be able to:
a. Discuss classification system for metals; and,
b. Describe general characteristics for carbon steels, tool steels, stainless steels, structural steels, cast irons, aluminum, and other commonly used metals.

Instructional Materials:

MASTER Handout (TLD-D1-HO1)
The following tables are included in this module for reference or reproduction as needed.
Table 1.1 "Effects of Alloying Elements on Steel" (TLD-D1-HO2)
Table 1.2 "SAE-ANSI Numerical Designation of Alloy Steels" (TLD-D1-HO3)
MASTER Self-Assessment

References:

Machine Tool Practices, Kibbe, Neely, and Meyer, Wiley Publishing, Latest Edition, "Selection and Identification of Steels" and "Selection and Identification of Non-Ferrous Metals"

NTMA Modules:

MA-II-46	"Physical Metallurgy"
MA-II-77	"Cast Irons"
MA-II-48	"Property of Metals"
MA-II-79	"Powder Metallurgy"
MA-II-50	"Iron Carbon Constitutional Diagram"
MA-II-57	"Steel Classification & Basic Tests for Identifying the Content of an Unknown Metal"
MA-II-59	"Plain Carbon Steel"
MA-II-67	"Alloy Steels and Stainless Steels"
MA-II-69	"Aluminum & Aluminum Alloys"
MA-II-71	"Magnesium & Magnesium Alloys"

MA-II-73 "Copper & Copper Alloys"
MA-II-75 "Other Nonferrous Metals & Cast Alloys"
Machinery's Handbook, Industrial Press, Latest Edition

Student Preparation:

None

Introduction:

It has become increasingly important for the technician to understand the properties of metals during the last few years. With more and more emphasis on weight reduction and increased strength in products such as automobiles and aircraft, the technician will be expected to work with many different types of carbon and alloy steels. So it is imperative that the technician understand the properties and identification system for metals commonly found in the machine shop.

Presentation Outline:

I. Discuss the Physical Properties of Metal
  A. Brittleness - the property of a metal which permits no permanent distortion before breaking
  B. Ductility - the ability of the metal to be permanently deformed without breaking
  C. Elasticity - the ability of a metal to return to its original shape after any force acting upon it has been removed
  D. Hardness - the resistance to forcible penetration
  E. Malleability - the property of a metal which permits it to be hammered or rolled into other sizes and shapes
  F. Tensile strength - the maximum amount of pull that a material will withstand before breaking
  G. Toughness - the property of a metal to withstand shock or impact
II. Discuss the Classification System for Steel
  A. Carbon steels
    1. Low carbon steel - contains from 0.02 to 0.20 percent of carbon
    2. Medium carbon steel - contains from 0.30 to 0.60 percent of carbon
    3. High carbon steel (tool steel) - contains over 0.60 percent of carbon
  B. Alloy steels - alloying elements allow steels to possess special characteristics
  Discuss Table 1.1 "Effects of Alloying Elements on Steel"
  Discuss Table 1.2 "SAE-ANSI Numerical Designation of Alloy Steels"
III. Describe General Characteristics For:

A. Carbon Steels
B. Tool Steels
C. Stainless Steels
D. Structural Steels
E. Cast Irons
F. Non-Ferrous Metals
    1. Aluminum and Its Alloys
    2. Copper and Its Alloys
    3. Nickel Alloys
    4. Precious Metals
    5. Others

Practical Application:

Students will be able to select metals based on their properties through understanding their physical characteristics and the standard coding system.

Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and answer student questions

Next Lesson Assignment:

MASTER Technical Module (TLD-D2) dealing with the identification of materials and processes used to produce a part.

TLD-D1-HO1
Identify Materials with Desired Properties
Attachment 1: MASTER Handout No. 1

Objective(s):

Upon completion of this unit the student will be able to:

- a. Discuss classification system for metals; and,
- b. Describe general characteristics for carbon steels, tool steels, stainless steels, structural steels, cast irons, aluminum, and other commonly used metals.

Module Outline:

- I. Discuss the Physical Properties of Metal
  - A. Brittleness - the property of a metal which permits no permanent distortion before breaking
  - B. Ductility - the ability of the metal to be permanently deformed without breaking
  - C. Elasticity - the ability of a metal to return to its original shape after any force acting upon it has been removed
  - D. Hardness - the resistance to forcible penetration
  - E. Malleability - the property of a metal which permits it to be hammered or rolled into other sizes and shapes
  - F. Tensile strength - the maximum amount of pull that a material will withstand before breaking
  - G. Toughness - the property of a metal to withstand shock or impact
- II. Discuss the Classification System for Steel
  - A. Carbon steels
    - 1. Low carbon steel - contains from 0.02 to 0.20 percent of carbon
    - 2. Medium carbon steel - contains from 0.30 to 0.60 percent of carbon
    - 3. High carbon steel (tool steel) - contains over 0.60 percent of carbon
  - B. Alloy steels - alloying elements allow steels to possess special characteristics
    Discuss Table 1.1 "Effects of Alloying Elements on Steel"
    Discuss Table 1.2 "SAE-ANSI Numerical Designation of Alloy Steels"
- III. Describe General Characteristics For:
  - A. Carbon Steels
  - B. Tool Steels
  - C. Stainless Steels
  - D. Structural Steels
  - E. Cast Irons

F. Non-Ferrous Metals
   1. Aluminum and Its Alloys
   2. Copper and Its Alloys
   3. Nickel Alloys
   4. Precious Metals
   5. Others

TLD-D1-HO2
Identify Materials With Desired Properties
Attachment 2: MASTER Handout No. 2

TABLES FOR TLD-D1 — PROPERTIES OF METALS
TABLE 1.1

THE EFFECT OF ALLOYING ELEMENTS ON STEEL

EFFECT	ELEMENT											
	Carbon	Chromium	Cobalt	Lead	Manganese	Molybdenum	Nickel	Phosphorus	Silicon	Sulfur	Tungsten	Vanadium
Increases tensile strength	X	X			X	X	X					
Increases hardness	X	X										
Increases wear resistance	X	X			X		X				X	
Increases hardenability	X	X			X	X	X					X
Increases ductility					X							
Increases elastic limit		X				X						
Increases rust resistance		X					X					
Increases abrasion resistance		X			X							
Increases toughness		X				X	X					X
Increases shock resistance		X					X					X
Increases fatigue resistance												X
Decreases ductility	X	X										
Decreases toughness			X									
Raises critical temperature		X	X								X	
Lowers critical temperature					X		X					
Causes hot shortness										X		
Causes cold shortness								X				
Imparts red hardness			X			X					X	
Imparts fine grain structure					X							X
Reduces deformation					X		X					
Acts as deoxidizer					X				X			
Acts as desulphurizer					X							
Imparts oil hardening properties		X			X	X	X					
Imparts air hardening properties					X	X						
Eliminates blow holes								X				
Creates soundness in casting									X			
Facilitates rolling and forging					X				X			
Improves machinability				X						X		

TLD-D1-HO3
Identify Materials With Desired Properties
Attachment 3: MASTER Handout No. 3

TABLE 1.2

SAE-AISI NUMERICAL DESIGNATION OF ALLOY STEELS *(X Represents Percent of Carbon in Hundredths)*	
Carbon Steels	
Plain carbon	10xx
Free-cutting, resulfurized	11xx
Manganese Steels	13xx
Nickel Steels	
.50% nickel	20xx
1.50% nickel	21xx
3.50% nickel	23xx
5.00% nickel	25xx
Nickel-Chromium Steels	
1.25% nickel, .65% chromium	31xx
1.75% nickel, 1.00% chromium	32xx
3.50% nickel, 1.57% chromium	33xx
3.00% nickel, .80% chromium	34xx
Corrosion and heat-resisting steels	303xx
Molybdenum Steels	
Chromium	41xx
Chromium-nickel	43xx
Nickel	46xx and 48xx
Chromium Steels	
Low-chromium	50xx
Medium-chromium	511xx
High-chromium	521xx
Chromium-Vanadium Steels	6xxx
Tungsten Steels	7xxx and 7xxxx
Triple-Alloy Steels	8xxx
Silicon-Manganese Steels	9xxx
Leaded steels	11Lxx (example)

Name______________________________ Date________________

TLD-D1
Identify Materials With Desired Properties
Self-Assessment

Circle the letter preceding the correct answer.

1. Using the SAE system, 1008 indicates:
   A. Plain carbon steel, 8% carbon.
   B. Plain carbon steel, 0.8% carbon
   C. Plain carbon steel, 0.08% carbon.
   D. Low-chromium steel, 0.08% carbon.
   E. None of the above answers is correct.

2. In the SAE system, triple-alloy steels are designated by the numeral:
   A. 6
   B. 7
   C. 8
   D. 9
   E. None of the above answers is correct.

3. The AISI system uses ___ to indicate the process used to manufacture the steel.
   A. Numerical prefixes
   B. Numerical suffixes
   C. Capital-letter prefixes
   D. Capital-letter suffixes
   E. None of the above answers is correct.

4. Which of the following does *not* increase the tensile strength of steel?
   A. Carbon
   B. Molybdenum
   C. Nickel
   D. All of the above elements increase the tensile strength of steel.
   E. None of the above answers is correct.

5. Which of the following elements decreases the *toughness* of steel?
   A. Cobalt
   B. Phosphorus
   C. Vanadium
   D. All of the above elements increase the toughness of steel.
   E. None of the above answers is correct.

6. Which of the following elements imparts *fine grain structure* to steel?
A. Chromium
B. Manganese
C. Silicon
D. Tungsten
E. None of the above answers is correct.

7. The AISI prefix *B* designates that the steel is:
A. Acid Bessemer carbon steel.
B. Basic open hearth carbon steel.
C. Acid open hearth carbon steel.
D. Brass.
E. None of the above answers is correct.

8. ___ steels have their own alphabetic classification system.
A. Stainless
B. Low-carbon
C. Tool
D. Austenitic
E. None of the above answers is correct.

9. ___ stainless steel cannot be hardened by quenching.
A. Austenitic
B. Ferritic
C. Martensitic
D. All of the above stainless steels can be hardened by quenching.
E. None of the above answers is correct.

10. Which of the following metals is magnetic?
A. Phosphorus
B. Silicon
C. Sulfur
D. All of the above metals are magnetic.
E. None of the above answers is correct.

TLD-D1
Identify Materials With Desired Properties
Self-Assessment Answer Key

1. C
2. C
3. C
4. D
5. A
6. B
7. A
8. C
9. A
10. E

TOOL & DIE and EDM SERIES

MASTER Technical Module No. TLD-D2

Subject: **Tool & Die and EDM** **Time: 6 Hrs.**

Duty: **Demonstrate Knowledge of Manufacturing Materials**
Task: Identify Materials and Processes to Produce a Part

Objective(s):

Upon completion of this unit the student will be able to:

a. Briefly describe and list the advantages and disadvantages for each of the following: casting processes, hot working processes, and cold working processes;
b. Discuss service requirements (strength, hardness, etc.);
c. Discuss fastening processes (fasteners, welding, bonding, etc.); and,
d. Discuss corrosion resistance methods.

Instructional Materials:

MASTER Handout (TLD-D2-HO)
MASTER Self Assessment
Several samples of parts treated to resist corrosion by different methods
Several fasteners and samples of different bonding agents
Samples of metals showing exemplary welds
Samples of parts made by each process covered by the instructor

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References:

Machine Tool Practices, Kibbe, Neely, and Meyer, Wiley Publishing, Latest Edition, Section on "Materials"
Machinery's Handbook, Industrial Press, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Module:
TLD-D1 "Identify Materials with Desired Properties"

Introduction:

As in all other crafts, the materials of machining determine the properties of the part. While two pieces may appear the same to the naked eye, different metals have different strengths; and the two pieces may differ markedly in their performance.

Therefore, the technician must be capable of identifying not only the material itself, but also its working properties.

Presentation Outline:

I. Describe Casting Processes
  A. Discuss the following casting processes: sand, evaporative, shell molding, permanent mold, centrifugal, investment, and die casting
  B. Discuss pattern and mold design factors for each of the above casting processes
  C. List the advantages and disadvantages of the casting processes
II. Describe Hot Working Processes
  A. Discuss the following hot working processes: rolling, strand casting, forging, drawing, extrusion, spinning, and roll forming
  B. List the advantages and disadvantages of the hot working processes
III. Describe Cold Working Processes
  A. Discuss the following cold working processes: rolling, blanking, pressing, drawing, extruding, wire and bar drawing, bending, shearing, and roll forming
  B. List the advantages and disadvantages of the cold working process
IV. Evaluate Alternative Manufacturing Processes
  A. Discuss the powder metallurgy process (PM)
  B. Discuss the following nontraditional machining processes: EDM, laser machining, ultrasonic machining, hydrojet machining, electron beam machining, and plasma beam machining

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Practical Application:

Students will be able to recognize fasteners forms, casting processes, and novel machining methods and to readily identify the uses and advantages of each.

Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-D3) dealing with classification systems for metal.

TLD-D2-HO
Identify Materials and Processes to Produce a Part
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Briefly describe and list the advantages and disadvantages for each of the following: casting processes, hot working processes, and cold working processes;
b. Discuss service requirements (strength, hardness, etc.);
c. Discuss fastening processes (fasteners, welding, bonding, etc.); and,
d. Discuss corrosion resistance methods.

Module Outline:

I. Describe Casting Processes
   A. Discuss the following casting processes: sand, evaporative, shell molding, permanent mold, centrifugal, investment, and die casting
   B. Discuss pattern and mold design factors for each of the above casting processes
   C. List the advantages and disadvantages of the casting processes
II. Describe Hot Working Processes
   A. Discuss the following hot working processes: rolling, strand casting, forging, drawing, extrusion, spinning, and roll forming
   B. List the advantages and disadvantages of the hot working processes
III. Describe Cold Working Processes
   A. Discuss the following cold working processes: rolling, blanking, pressing, drawing, extruding, wire and bar drawing, bending, shearing, and roll forming
   B. List the advantages and disadvantages of the cold working process
IV. Evaluate Alternative Manufacturing Processes
   A. Discuss the powder metallurgy process (PM)
   B. Discuss the following nontraditional machining processes: EDM, laser machining, ultrasonic machining, hydrojet machining, electron beam machining, and plasma beam machining

Name______________________________ Date_________________

TLD-D2
Identify Materials and Processes to Produce a Part
Self-Assessment

Circle the letter preceding the correct answer.

1. In ___ casting, the mold is composed of sand and resin.
    A. Green-sand
    B. Shell
    C. V-process
    D. Squeeze
    E. None of the above answers is correct.

2. Which of the following is *not* a method of injecting material into a mold?
    A. Gravitic flow
    B. Pressure
    C. Centrifugal force
    D. All of the above are methods of injecting material into a mold.
    E. None of the above answers is correct.

3. What is the *skin effect?*
    A. The vacuoles created when the surface of a casting cools faster than its interior
    B. The thin, weak, exterior layer on castings caused by improper mixing of alloys
    C. The layers of metal formed in die casting
    D. Abrasions caused by excessive polishing of the casting
    E. Goose bumps

4. Die castings should be designed with ___ to relieve cooling stresses.
    A. Cores of simple shapes
    B. Heavy sections
    C. Small cores
    D. Uniform wall thicknesses
    E. None of the above answers is correct.

5. Which of the following is a major problem of the hot extrusion process?
    A. Cost of glass-powder lubricants
    B. Graphite lubricants contaminating the billet
    C. Construction of the equipment
    D. Scarcity of metals that can be successfully extruded
    E. None of the above answers is correct.

6. Extrusion generates ___ force, but not ___ force.
   A. Tensile. . .compressive
   B. Tensile. . .shear
   C. Compressive. . .shear
   D. Compressive. . .tensile
   E. None of the above answers is correct.

7. Plasma cutters can generate heat in excess of:
   A. 20,000°F.
   B. 30,000°F.
   C. 40,000°F.
   D. 80,000°F.
   E. 120,000°F.

8. Which of the following is *not* an advantage of EDM?
   A. Localized heat treating
   B. Extremely fine detail is possible.
   C. Can be used on very hard metals.
   D. All of the above answers are valid.
   E. None of the above answers is correct.

9. Which of the following processes would be most advantageous for internal deburring operations?
   A. ECDB
   B. Hydrojet machining
   C. Plasma machining
   D. Laser machining
   E. None of the above answers is correct.

10. What is meant by *ELG?*
   A. Extremely Large Gauge
   B. Electrolytic Grinding
   C. Emerald Laser Grinding
   D. Electron-Lathe Guide
   E. None of the above answers is correct.

TLD-D2
Identify Materials and Processes to Produce a Part
Self-Assessment Answer Key

1. B

2. D

3. C

4. D

5. C

6. D

7. C

8. A

9. A

10. B

TOOL & DIE and EDM SERIES

MASTER Technical Module No. TLD-D3

Subject: **Tool & Die and EDM** **Time: 8 Hrs.**

Duty: **Demonstrate Knowledge of Manufacturing Materials**
Task: Discuss Classification Systems for Metal

Objective(s):

Upon completion of this unit the student will be able to:
- a. Identify organizations that classify metals;
- b. Distinguish between types of metal by manufacturing method and/or shape;
- c. Identify designation of each digit of a metal classification;
- d. Identify carbon and alloy content of a metal using classification system;
- e. Identify content of an unknown metal using shop tests; and,
- f. Identify conformity of a metal to a specification system.

Instructional Materials:

MASTER Handout (TLD-D3-HO1)
MASTER Handout (TLD-D3-HO2)
MASTER Handout (TLD-D3-HO3)
MASTER Handout (TLD-D3-HO4)
MASTER Laboratory Aid (TLD-D3-LA)
MASTER Worksheet (TLD-D3-LW)
MASTER Self-Assessment
Random collection of objects for student practice (shop tests) and observation

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References:

The following NTMA Machinist Training Modules are recommended as reference material:

MA-II-57	"Metallurgy: Steel Classifications & Basic Tests for Identifying the Content of an Unknown Metal"
MA-II-59	"Metallurgy: Plain Carbon Steel"
MA-II-67	"Metallurgy: Alloy Steels and Stainless Steels"
MA-II-69	"Metallurgy: Aluminum and Aluminum Alloys"
MA-II-71	"Metallurgy: Magnesium and Magnesium Alloys"
MA-II-73	"Metallurgy: Copper and Copper Alloys"
MA-II-75	"Metallurgy: Other Nonferrous Metals and Cast Alloys"

MA-II-77 "Metallurgy: Cast Irons"

Student Preparation:

Students should have previously completed the following Technical Modules:

TLD-D1 "Identify Materials With Desired Properties"
TLD-D2 "Identify Materials and Processes to Produce a Part"

Introduction:

When there was only wrought iron and plain carbon steel available, separating and identifying metals was relatively simple. Now, however, with the hundreds of different compositions in use, identification would be confusing without some means of reference or classification. Several different numbering systems have been developed by various organizations to classify metals and alloys according to content, properties, manufacturing process, or intended use. A Tool and Die Maker must be capable of distinguishing between materials by understanding these systems and their designations.

Presentation Outline:

I. Identify the Organizations That Classify Metals and Discuss the Significance of Each
    A. American Iron and Steel Institute (AISI)
    B. Society of Automotive Engineers (SAE)
    C. American Society for Testing and Materials (ASTM)
    D. American National Standards Institute (ANSI)
    E. Aluminum Association
II. Identify Classifications by Manufacturing Methods or Processes
    A. Hot rolled
    B. Cold rolled
    C. Turned and polished (sometimes referred to as ground and polished)
    D. Castings
    E. Forgings
    F. Galvanized
III. Identify Classifications by Shape
    A. Sheet and plate
    B. Bar stock
    C. Pipe and tubing
    D. Rod and wire
    E. Coil or strip
    F. Structural steel
IV. Discuss the AISI-SAE Numbering Systems for Carbon Steels
    A. Plain carbon steels (AISI-SAE 10xx and 15xx)

- B. Free-cutting steels (AISI-SAE 11xx and 12xx)

V. Discuss the AISI-SAE Classification Systems for Alloy Steels
  - A. Manganese steels (AISI-SAE 13xx)
  - B. Nickel steels (AISI-SAE 2xxx)
  - C. Nickel-chromium steels (AISI-SAE 3xxx)
  - D. Molybdenum steels (AISI-SAE 4xxx)
  - E. Low chromium steels (AISI-SAE 5xxx)
  - F. Other alloy steels (AISI-SAE 61xx, 8xxx, and 9xxx)

VI. Discuss the AISI-SAE Classification of Stainless Steels
  - A. Chromium-nickel austenitic steels (SAE 30xxx or AISI 20x and 3xx)
  - B. Ferritic chromium steels (SAE 51xxx or AISI 4xx and 50x)
  - C. Martensitic chromium steels (SAE 51xxx or AISI 4xx and 50x)

VII. Discuss the AISI Classification of Tool Steels
  - A. High speed tool steels (AISI type M and T)
  - B. Hot work tool steels (AISI type H)
  - C. Cold work tool steels (AISI type D, A, and O)
  - D. Shock resisting tool steels (AISI type S)
  - E. Mold steels (AISI type P)
  - F. Special purpose tool steels (AISI type L and F)
  - G. Water hardening tool steels (AISI type W)

VIII. Discuss the Classification of Nonferrous Alloys
  - A. Aluminum and aluminum alloys (Aluminum Association four digit system)
  - B. Magnesium alloys (SAE type 5x and 5xx)
  - C. Nickel and nickel alloys (by name)
  - D. Titanium and titanium alloys (titanium and chief alloying element)
  - E. Copper and copper alloys (by name and SAE standard number)

IX. Discuss the Classification of Castings
  - A. Brass and bronze castings (SAE standard number)
  - B. Aluminum casting alloys (Aluminum Association four digit system)
  - C. Cast Iron (ASTM grade)
  - D. Steel Castings (ASTM grade)

X. Discuss the Unified Numbering System (UNS) for Metals and Alloys

XI. Discuss the Basic Identification of an Unmarked Piece of Steel Using Shop Tests
  - A. Observation
  - B. Magnet test
  - C. Hardness test
  - D. Scratch test
  - E. File test
  - F. Chemical test
  - G. Spark test

XII. Identify Specification Systems for Metals and Alloys
  - A. American Society for Testing and Materials (ASTM)
  - B. American National Standards Institute (ANSI)

C. U.S. Department of Defense (military specifications)
D. General Accounting Office (federal specifications)

Practical Application:

Students will practice identifying materials by their nomenclature and by shop tests. Each student will then complete the Laboratory Worksheet and turn into the instructor for checking.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the following components:

a. Identify organizations that classify metals;
b. Identify metal type given a classification;
c. Identify content of a metal given a classification;
d. Identify content of an unknown metal using shop tests;
e. Identify conformity of a metal given an ASTM specification; and,
f. Self-Assessment.

Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-E1) dealing with understanding metrology terms.

TLD-D3-HO1
Discuss Classification Systems for Metal
Attachment 1: MASTER Handout No. 1

Objective(s):

Upon completion of this unit the student will be able to:

a. Identify organizations that classify metals;
b. Distinguish between types of metal by manufacturing method and/or shape;
c. Identify designation of each digit of a metal classification;
d. Identify carbon and alloy content of a metal using classification system;
e. Identify content of an unknown metal using shop tests; and,
f. Identify conformity of a metal to a specification system.

Module Outline:

I. Identify the Organizations That Classify Metals and Discuss the Significance of Each
    A. American Iron and Steel Institute (AISI)
    B. Society of Automotive Engineers (SAE)
    C. American Society for Testing and Materials (ASTM)
    D. American National Standards Institute (ANSI)
    E. Aluminum Association
II. Identify Classifications by Manufacturing Methods or Processes
    A. Hot rolled
    B. Cold rolled
    C. Turned and polished (sometimes referred to as ground and polished)
    D. Castings
    E. Forgings
    F. Galvanized
III. Identify Classifications by Shape
    A. Sheet and plate
    B. Bar stock
    C. Pipe and tubing
    D. Rod and wire
    E. Coil or strip
    F. Structural steel
IV. Discuss the AISI-SAE Numbering Systems for Carbon Steels
    A. Plain carbon steels (AISI-SAE 10xx and 15xx)
    B. Free-cutting steels (AISI-SAE 11xx and 12xx)
V. Discuss the AISI-SAE Classification Systems for Alloy Steels
    A. Manganese steels (AISI-SAE 13xx)

   - B. Nickel steels (AISI-SAE 2xxx)
   - C. Nickel-chromium steels (AISI-SAE 3xxx)
   - D. Molybdenum steels (AISI-SAE 4xxx)
   - E. Low chromium steels (AISI-SAE 5xxx)
   - F. Other alloy steels (AISI-SAE 61xx, 8xxx, and 9xxx)

VI. Discuss the AISI-SAE Classification of Stainless Steels
   - A. Chromium-nickel austenitic steels (SAE 30xxx or AISI 20x and 3xx)
   - B. Ferritic chromium steels (SAE 51xxx or AISI 4xx and 50x)
   - C. Martensitic chromium steels (SAE 51xxx or AISI 4xx and 50x)

VII. Discuss the AISI Classification of Tool Steels
   - A. High speed tool steels (AISI type M and T)
   - B. Hot work tool steels (AISI type H)
   - C. Cold work tool steels (AISI type D, A, and O)
   - D. Shock resisting tool steels (AISI type S)
   - E. Mold steels (AISI type P)
   - F. Special purpose tool steels (AISI type L and F)
   - G. Water hardening tool steels (AISI type W)

VIII. Discuss the Classification of Nonferrous Alloys
   - A. Aluminum and aluminum alloys (Aluminum Association four digit system)
   - B. Magnesium alloys (SAE type 5x and 5xx)
   - C. Nickel and nickel alloys (by name)
   - D. Titanium and titanium alloys (titanium and chief alloying element)
   - E. Copper and copper alloys (by name and SAE standard number)

IX. Discuss the Classification of Castings
   - A. Brass and bronze castings (SAE standard number)
   - B. Aluminum casting alloys (Aluminum Association four digit system)
   - C. Cast Iron (ASTM grade)
   - D. Steel Castings (ASTM grade)

X. Discuss the Unified Numbering System (UNS) for Metals and Alloys

XI. Discuss the Basic Identification of an Unmarked Piece of Steel Using Shop Tests
   - A. Observation
   - B. Magnet test
   - C. Hardness test
   - D. Scratch test
   - E. File test
   - F. Chemical test
   - G. Spark test

XII. Identify Specification Systems for Metals and Alloys
   - A. American Society for Testing and Materials (ASTM)
   - B. American National Standards Institute (ANSI)
   - C. U.S. Department of Defense (military specifications)
   - D. General Accounting Office (federal specifications)

TLD-D3-HO2
Discuss Classification Systems for Metal
Attachment 2: MASTER Handout No. 2

AISI-SAE STANDARD STEELS CLASSIFICATION

AISI-SAE	Type of Steel and Nominal Alloy Content
Carbon Steels	
10xx	Plain Carbon (Max 1% Mn.)
15xx	Plain Carbon (Max 1% - 1.65% Mn.)
11xx	Free Cutting, Resulfurized
12xx	Free Cutting, Resulfurized and Rephosporized
Manganese Steels	
13xx	1.75% Manganese
Nickel Steels	
23xx	3.50% Nickel
25xx	5.00% Nickel
Nickel-Chromium Steels	
31xx	1.25% Nickel; 0.65% and 0.80% Chromium
32xx	1.75% Nickel; 1.07% Chromium
33xx	3.50% Nickel; 1.50% and 1.57% Chromium
34xx	3.00% Nickel; 0.77% Chromium
Molybdenum Steels	
40xx	0.20% and 0.25% Molybdenum
44xx	0.40% and 0.52% Molybdenum
Chromium-Molybdenum Steels	
41xx	0.50% - 0.95% Chromium; 0.12% - 0.30% Molybdenum
Nickel-Molybdenum Steels	
46xx	0.85% and 1.82% Nickel; 0.20% and 0.25% Molybdenum
48xx	3.50% Nickel; 0.25% Molybdenum
Chromium Steels	
50xx	0.27% - 0.65% Chromium
51xx	0.80% - 1.05% Chromium
50xxx	0.50% Chromium; Min. 1.00% Carbon
51xxx	1.02% Chromium; Min. 1.00% Carbon
52xxx	1.45% Chromium; Min. 1.00% Carbon
Chromium-Vanadium Steels	
61xx	0.60% - 0.95% Chromium; 0.10% and 0.15% Vanadium
Tungsten-Chromium Steels	
72xx	1.75% Tungsten; 0.75% Chromium
Triple Alloy Steels	
43xx	1.82% Nickel; 0.50% and 0.80% Chromium; 0.25% Molybdenum
47xx	1.05% Nickel; 0.45% Chromium; 0.20% and 0.35% Molybdenum
8xxx	0.30% - 0.55% Nickel; 0.40% - 0.50% Chromium; 0.12% - 0.35% Molybdenum
92xx	1.40% and 2.00% Silicon; 0.00% and 0.65% Chromium; 0.65% - 0.85% Manganese
93xx	3.25% Nickel; 1.20% Chromium; 0.12% Molybdenum
94xx	0.45% Nickel; 0.40% Chromium; 0.12% Molybdenum
98xx	1.00% Nickel; 0.80% Chromium; 0.25% Molybdenum

AISI	SAE	Stainless Steel
2xx	302xx	Austentic Steels; 16% - 19% Chromium; 1% - 5.5% Nickel
3xx	303xx	Austentic Steels; 16% - 24% Chromium; 6% - 15% Nickel
4xx	514xx	Ferritic or Martensitic Steels; 10.5% - 18% Chromium
5xx	515xx	Ferritic or Martensitic Steels; 4% - 6% Chromium

TLD-D3-HO3
Discuss Classification Systems for Metal
Attachment 3: MASTER Handout No. 3

AISI TOOL STEELS CLASSIFICATION

CATEGORY DESIGNATION	AISI	GROUP DESIGNATION
High Speed Tool Steels	M T	Molybdenum Types Tungsten Types
Hot Work Tool Steels	H1 - H19 H20 - H39 H40 - H59	Chromium Types Tungsten Types Molybdenum Types
Cold Work Tool Steels	D A O	High Carbon, High Chromium Types Medium Alloy, Air Hardening Types Oil Hardening Types
Shock Resisting Tool Steels	S	-----
Mold Steels	P	-----
Special Purpose Tool Steels	L F	Low Alloy Types Carbon Tungsten Types
Water Hardening Tool Steels	W	-----

UNIFIED NUMBERING SYSTEM (UNS) FOR METALS & ALLOYS

UNS SERIES	METAL
	Nonferrous Metals and Alloys
A00001 to A99999	Aluminum and Aluminum Alloys
C00001 to C99999	Copper and Copper Alloys
E00001 to E99999	Rare Earth and Rare Earth-Like Metals and Alloys
L00001 to L99999	Low Melting Metals and Alloys
M00001 to M99999	Miscellaneous Nonferrous Metals and Alloys
P00001 to P99999	Precious Metals and Alloys
R00001 to R99999	Reactive and Refractory Metals and Alloys
Z00001 to Z99999	Zinc and Zinc Alloys
	Ferrous Metals and Alloys
D00001 to D99999	Specified Mechanical Property Steels
F00001 to F99999	Cast Irons
G00001 to G99999	AISI and SAE Carbon and Alloy Steels (Except Tool Steels)
H00001 to H99999	AISI H-Steels
J00001 to J99999	Cast Steels (Except Tool Steels)
K00001 to K99999	Miscellaneous Steels and Ferrous Alloys
S00001 to S99999	Heat and Corrosion Resistant (Stainless Steels)
T00001 to T99999	Tool Steels

TLLD-D3-HO4
Discuss Classification Systems for Metal
Attachment 4: MASTER Handout No. 4
EXAMPLE OF A SPECIFICATION

HOT ROLLED CARBON STEEL BARS							
Size	Tolerance		Out-of-Section	Size	Tolerance		Out-of-Section
	Plus	Minus			Plus	Minus	
Rounds, Squares and Round-Cornered Squares							
To 5/16	.005	.005	.008	Over 1-1/2 to 2	1/64	1/64	.023
Over 5/16 to 7/16	.006	.006	.009	Over 2 to 2-1/2	1/32	0	.023
Over 7/16 to 5/8	.007	.007	.010	Over 2-1/2 to 3-1/2	3/64	0	.035
Over 5/8 to 7/8	.008	.008	.012	Over 3-1/2 to 4-1/2	1/16	0	.046
Over 7/8 to 1	.009	.009	.013	Over 4-1/2 to 5-1/2	5/64	0	.058
Over 1 to 1-1/8	.010	.010	.015	Over 5-1/2 to 6-1/2	1/8	0	.070
Over 1/18 to 1-1/4	.011	.011	.016	Over 6-1/2 to 8-1/4	5/32	0	.085
Over 1-1/4 to 1-38	.012	.012	.018	Over 8-1/4 to 9-1/2	3/16	0	.100
Over 1-3/8 to 1-1/2	.014	.014	.021	Over 9-1/2 to 10	1/4	0	.120
Hexagons							
To 1/2	.007	.007	.011	Over 1-1/2 to 2	1/32	1/64	1/32
Over 1/2 to 1	.010	.120	.015	Over 2 to 2-1/2	3/64	1/64	3/64
Over 1 to 1-1/2	.021	.130	.025	Over 2-1/2 to 3-1/2	1/16	1/64	1/16

COLD FINISHED CARBON STEELS							
Size	Max. % Carbon			Size	Max. % Carbon		
	Up to .28	Over .28 to .55	Over .55		Up to .28	Over .28 to 55	Over .55
	Minus Tolerance				Minus Tolerance		
Cold Drawn Rounds				Cold Drawn Flats			
To 1-1/2	.002	.003	.005	To 3/4	.003	.004	.008
Over 1-1/2 to 2-1/2	.003	.004	.006	Over 3/4 to 1-1/2	.004	.005	.010
Over 2-1/2 to 4	.004	.005	.007	Over 1-1/2 to 3	.005	.006	.012
Over 4 to 6	.005	.006	.008	Over 3 to 4	.006	.008	0.016
				Over 4 to 6	.008	.010	.020
				Over 6	.013	.015	-----
Cold Drawn Hexagons				Cold Drawn Squares			
To 3/4	.002	.003	.006	To 3/4	.002	.004	.007
Over 3/4 to 1-1/2	.003	.004	.007	Over 3/4 to 1-1/2	.003	.005	.008
Over 1-1/2 to 2-1/2	.004	.005	.008	Over 1-1/2 to 2-1/2	.004	.006	.009
Over 2-1/2 to 3-1/8	.005	.006	.009	Over 2-1/2 to 4	.005	.008	.011
Turned and Polished Rounds							
To 1-1/2	.002	.003	.005	Over 4 to 6	.005	.006	.008
Over 1-1/2 to 2-1/2	.003	.004	.006	Over 6 to 8	.006	.007	.009
Over 2-1/2 to 4	.004	.005	.007	Over 8 to 9	.007	.008	.010

List of Materials for Shop Tests and Illustration

1. **Observation Test**
   Sample of round bars with various surface finishes (cold finished, hot rolled, ground and polished)

2. **Magnet Test**
   Sample of carbon steel, ferritic or martensitic stainless steel, austenitic stainless steel, aluminum, and nickel steel

3. **Hardness Test**
   Sample of mild steel, medium carbon steel, high carbon steel, alloy steel, and tool steel

4. **Scratch Test**
   Sample of mild steel, medium carbon steel, high carbon steel, alloy steel, and tool steel

5. **File Test**
   Sample of mild steel, medium carbon steel, high carbon steel, alloy steel, and tool steel

6. **Chemical Test**
   Sample of carbon steel, type 302 or 304 stainless steel, type 316 or 317 stainless steel

7. **Spark Test**
   Sample of low carbon steel, high carbon steel, cast iron, high speed steel, tool steel, and manganese steel

8. **Observation Test**
   Samples of bar stock (round and square), hot rolled sheet, cold finished coil strip, galvanized sheet, small diameter pipe, small diameter tubing, small gauge wire, hot rolled rod, and cold finished rod

TLD-D3-LW
Discuss Classification Systems for Metal
Attachment 6: MASTER Laboratory Worksheet

I. Identify the following:

a. AISI ______________________________

b. SAE ______________________________

c. ASTM ______________________________

d. ANSI ______________________________

e. UNS ______________________________

II. **Complete the following charts:**

A. Standard Steels and Alloy Steels

	AISI-SAE	APP. % CARBON	MAJOR ALLOYING ELEMENTS
Ex.	1020	.20	Only Carbon
Ex.	6118	.18	Chromium & Vanadium
Ex.	4340	.40	Nickel, Chromium, Molybdenum
1.	1040		
2.	1095		
3.	1212		
4.	1340		
5.	2340		
6.	2512		
7.	3140		
8.	3310		
9.	4024		
10.	4140		
11.	4320		
12.	4620		
13.	5135		
14.	52100		
15.	6150		

B. AISI-SAE-UNS Classification System

	AISI-SAE	UNS	TYPE METAL OR STEEL
Ex.	1212	G12120	Free Cutting Carbon Steel
Ex.	48xx	G48xx0	Nickel- Molybdenum Steel
Ex.	A6	T30106	Air Harden Cold Work Tool Steel
1.	1527		
2.	1151		
3.		G10290	
4.		G41xx0	
5.		G61500	
6.			Tungsten-Chromium Steels
7.			Austenitic Stainless Steels
8.			Nickel Steels
9.	H21	T20821	
10.		T12002	Tungsten High Speed Tool Steels
11.	Sx	T4190x	
12.	D2	T30402	
13.		T41906	Shock Resisting Tool Steels
14.	-----	Axxxxx	
15.			Copper and Copper Alloy

III. Answer the following questions:

A.. What is the out-of-round tolerance for 2-1/2" diameter hot rolled bar?

B. What is the size tolerance for 1-3/4" cold finished hexagon bar made from 1045?

C. If the only requirements given you were 1" 1018 square bar with a size tolerance of -.006, would you choose hot rolled (much cheaper) or cold finished stock?

____

____

IV. Record the results of your shop test below.

Item No.	Test Used	Kind of Metal
1.		
2.		
3.		
4.		
5.		

Name:____________________ Date:________________

TLD-D3

Discuss Classification Systems for Metal

Self-Assessment

1. Who is the AISI?

2. Who is the SAE?

3. What organization's classification system of aluminum and aluminum alloys is accepted by industry and used by commercial producers?

4. What organization has published a specification system for metals and alloys?

5. Name three classes of metals by manufacturing method, process, or material finish.

6. Identify four basic shapes that metals are produced in.

7. What do the first two digits of a steel name designate?

8. What do the last two digits (in a four-digit name) designate?

9. What is the approximate percent of carbon in 1045 carbon steel?

10. What is the approximate percent of carbon in 52100 chromium steel?

11. What type steel is 4147?

12. What is the alloying element in 2517 steel? What percent of that element is present?

13. If the element chromium makes steel stainless, why are the 5xxx and 5xxxx steels not included in the stainless steel group?

14. Name three types of stainless steel.

15. Which types are magnetic?

16. What element is added to austenitic stainless steels to improve ductility and other properties?

17. What type steel is indicated by the symbol W1 or A6?

18. What type tool steel is designated by the symbol D (category and group designations)?

19. What three groups of cold work tool steels are available?

20. What is the designation for water hardening tool steel?

21. Identify three categories of nonferrous alloys.

22. What category of nonferrous metals does brass and bronze belong to?

23. What does the first digit of an aluminum designation identify?

24. What are the basic temper designations and subdivisions for aluminum alloys?

25. Name 5 basic types of cast iron.

26. Name 2 basic types of steel castings.

27. What is the UNS designation for 1212 free cutting carbon steel?

28. What type metal are the T series numbers reserved for in the UNS numbering system?

29. What does a G as the first digit of a UNS classification designate?

30. What is the AISI-SAE classification for a G13300 steel?

31. When checking the hardness of a piece of steel with the file test, the file slides over the surface without cutting. What type steel is it most likely to be?

32. What can you determine about a metal by observation?

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33. If an unknown sample can not be scratched by a piece of mild steel keystock but the keystock can be scratched by the sample, what conclusion can you draw about the sample?

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34. If a hardness tester is not available, how can you determine relative hardness of a sample?

____

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35. When spark testing a sample to determine carbon content, what does orange carrier lines ending in pear-shaped globules and very little branching indicate?

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36. What is the out-of-round tolerance for 2-1/2" diameter hot rolled bar?

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37. What is the maximum width of 1-1/4" key made from 1045 cold finished square bar? What is the minimum width?

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38. What is the maximum diameter of a shaft made from 5" hot rolled 1018 bar? What is the minimum?

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39. Name two other specification systems in use.

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40. Define color coding and explain what it is used for.

____

____

____

TOOL AND DIE MAKER .... skilled workers who produce tools, dies, and special guiding and holding devices that are used in machining.

Duties ← **Tasks** →

A	Practice Safety	A-1 Follow safety manuals and all safety regulations/ requirements	A-2 Maintain safe equipment and machinery	A-3 Use safe operating procedures for hand and machine tools	A-4 Maintain a clean and safe work environment	A-5 Use safe material handling practices	A-6 Consult and apply MSDS for hazards of various materials							
B	Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Perform basic algebraic operations	B-3 Use basic geometric principles	B-4 Perform basic trigonometric functions	B-5 Use and apply Cartesian Coordinate System								
C	Interpret Engineering Drawings and Related Documents	C-1 Interpret and understand basic layout/types of drawings	C-2 Interpret, review, and apply blueprint notes, dimensions, and tolerances	C-3 Use and apply Geometric Dimensioning and Tolerancing (GD&T)	C-4 Demonstrate traditional mechanical drafting and sketching techniques	C-5 Understand and use quality systems								
D	Demonstrate Knowledge of Manufacturing Materials	D-1 Identify materials with desired properties	D-2 Identify materials and processes to produce a part	D-3 Discuss classification systems for metal										
E	Measure/ Inspect	E-1 Understand metrology terms	E-2 Select measurement tools	E-3 Measure with hand held instruments	E-4 Eliminate measurement variables	E-5 Measure/inspect using surface plate and accessories	E-6 Inspect using ... stationary equipment							
F	Demonstrate Knowledge of Manufacturing Processes	F-1 Discuss metal cutting and metal cutting tools	F-2 Operate metal saws	F-3 Operate drill presses and tooling	F-4 Operate engine and turret lathes and tooling	F-5 Operate vertical and horizontal mills and tooling	F-6 Operate precision grinders	F-7 Operate heat treating equipment and processes	F-8 Operate sheet metal equipment	F-9 Operate welding equipment and processes	F-10 Estimate time required/ cost to produce a part			
G	Use Computers	G-1 Use computer operating systems	G-2 Understand computer terminology	G-3 Use file management systems	G-4 Install and use software packages									
H	Perform CAD/ CAM and CNC Programming Tasks	H-1 Discuss fundamentals of CNC machines and controls	H-2 Program and operate CNC milling machine and machining center	H-3 Program and operate CNC lathe	H-4 Use Computer-Aided Drafting (CAD) system	H-5 Create 3-D solid models	H-6 Use Computer-Aided Manufacturing (CAM) system							
I	Perform Tool and Die Making Operations	I-1 Discuss basic types and functions of jigs and fixtures	I-2 Utilize concepts of jig and fixture design	I-3 Demonstrate understanding of different types of industrial dies	I-4 Utilize basic die theory	I-5 Utilize principles of die design	I-6 Perform tool and die repair	I-7 Demonstrate tool and die making skills						
J	Operate Electrical Discharge Machine (EDM)	J-1 Discuss fundamentals of EDM	J-2 Setup and operate conventional sinker EDM	J-3 Program, setup, and operate CNC sinker EDM and EDM drill	J-4 Program, setup, and operate CNC wire EDM									

DutyE

TLD-E1

TOOL & DIE and EDM SERIES

MASTER Technical Module No. TLD-E1

Subject: **Tool & Die and EDM** **Time: 2 Hrs.**

Duty: **Measure/Inspect**
Task: Understand Metrology Terms

Objective(s):

Upon completion of this unit the student will be able to:

a. Discuss the use of metrology in manufacturing;
b. Discuss the Inch system of measurement;
c. Discuss the Metric system of measurement;
d. Discuss semi-precision and precision measurement; and,
e. Discuss the following: precision, reliability, discrimination, and accuracy.

Instructional Materials:

MASTER Handout (TLD-E1-HO)
MASTER Self-Assessment
As many different measurement instruments in both English and metric as is practical

References:

Machine Tool Practices, Kibbe, Neely, and Meyer, Wiley Publishing, Latest Edition, "Dimensional Measurement"
NTMA Modules:
  MA-I-35 "Fractions"
  MA-II-05 "Metric Measurement"

Student Preparation:

Students should have previously completed the following Technical Modules:
  TLD-B1 "Perform Basic Arithmetic Functions"

Introduction:

The world has depended on some form of measurement system since the beginning of civilization. Measurement has progressed through many forms down through the years. Measurement is now referred to as metrology and has, by necessity, become an exact science because of the high degrees of precision required by manufactures and consumers today. Interchangeable manufacture, world trade, and the need for high precision have all contributed to the need for a highly accurate international system of measurement.

Presentation Outline:

I. Discuss the Use of Metrology in Manufacturing
   A. Discuss the function and reason for measurements in manufacturing
   B. Discuss the changes (metrology related) in manufacturing today
      1. Interchangeable manufacture
      2. World trade
      3. High precision
II. Discuss the Inch System of Measurement
   A. Discuss fractional (scale) dimensions for linear measurement
   B. Discuss decimal dimensions for linear measurement
   C. Convert fractional to decimal
      1. Review mathematical conversion method
      2. Fractional/decimal conversion charts
   D. Practice and demonstration of skills listed above
III. Discuss the Metric System of Measurement
   A. Discuss the units of measure commonly used in the metric system
   B. Convert inch to metric
      1. Review mathematical method (1 inch = 25.4 mm)
      2. Conversion charts
   C. Practice and demonstration of skills listed above
IV. Discuss Semi-Precision and Precision Measurement
   A. Discuss the difference between semi-precision and precision measurement
      1. Semi-precision measurements are 1/64" (.5mm) or greater
      2. Precision measurements are less than 1/64" (.5mm)
   B. Discuss the five categories of precision measurement
      1. Outside measurement
      2. Inside measurement
      3. Depth measurement
      4. Thread measurement
      5. Height measurement
V. Discuss the Following Measurement Terms: Accuracy, Precision, Reliability, and Discrimination
   A. *Accuracy* - whether or not something is made according to standard. (The standard for manufacturing is the blueprint.)
   B. *Precision* - the degree of exactness required for an application or design requirement
   C. *Reliability* - the ability to consistently obtain the desired result

D. *Discrimination* - the degree that a measuring instrument divides its basic unit of length

Practical Application:

Students will understand the differences in metric and English measurements, will recognize different measuring tools, and will understand the principles of precision measurement.

Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-E2) dealing with the selection of the correct measuring tool based on tool characteristics and measurement requirements.

TLD-E1-HO
Understand Metrology Terms
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Discuss the use of metrology in manufacturing;
b. Discuss the Inch system of measurement;
c. Discuss the Metric system of measurement;
d. Discuss semi-precision and precision measurement; and,
e. Discuss the following: precision, reliability, discrimination, and accuracy.

Module Outline:

I. Discuss the Use of Metrology in Manufacturing
  A. Discuss the function and reason for measurements in manufacturing
  B. Discuss the changes (metrology related) in manufacturing today
    1. Interchangeable manufacture
    2. World trade
    3. High precision
II. Discuss the Inch System of Measurement
  A. Discuss fractional (scale) dimensions for linear measurement
  B. Discuss decimal dimensions for linear measurement
  C. Convert fractional to decimal
    1. Review mathematical conversion method
    2. Fractional/decimal conversion charts
  D. Practice and demonstration of skills listed above
III. Discuss the Metric System of Measurement
  A. Discuss the units of measure commonly used in the metric system
  B. Convert inch to metric
    1. Review mathematical method (1 inch = 25.4 mm)
    2. Conversion charts
  C. Practice and demonstration of skills listed above
IV. Discuss Semi-Precision and Precision Measurement
  A. Discuss the difference between semi-precision and precision measurement
    1. Semi-precision measurements are 1/64" (.5mm) or greater
    2. Precision measurements are less than 1/64" (.5mm)
  B. Discuss the five categories of precision measurement
    1. Outside measurement
    2. Inside measurement
    3. Depth measurement

        4. Thread measurement
        5. Height measurement

V. Discuss the Following Measurement Terms: Accuracy, Precision, Reliability, and Discrimination
    A. *Accuracy* - whether or not something is made according to standard. (The standard for manufacturing is the blueprint.)
    B. *Precision* - the degree of exactness required for an application or design requirement
    C. *Reliability* - the ability to consistently obtain the desired result
    D. *Discrimination* - the degree that a measuring instrument divides its basic unit of length

Name____________________________ Date________________

TLD-E1
Understand Metrology Terms
Self-Assessment

Circle the letter preceding the correct answer.

1. Which of the following is not a term for the science of measuring?
   A. Calibration
   B. Comparison
   C. Measurology
   D. Metrology

2. Name two systems of measurement presently used in the United States.
   A. Fractions and decimals
   B. Metric and inch
   C. Precision and non-precision
   D. Inside and outside

3. What is the most common inch to metric conversion factor in use today?
   A. 1" = 25.4mm
   B. 1mm = .25.4"
   C. 1' = 12mm
   D. 1/16" = 64mm

4. Precision measurement can be defined as any measurement made to a degree finer than:
   A. 1/8".
   B. 1/16".
   C. 1/32".
   D. 1/64".

5. Precision measurement can also be defined as any measurement made to a degree finer than:
   A. .25mm.
   B. .5mm.
   C. .10mm.
   D. 3.24mm.

6. _______________ in metrology refers to whether or not a specific measurement is actually within its stated size.
   A. Precision
   B. Reliability
   C. Discrimination
   D. Accuracy

7. _______________ in metrology is relative to the specific measurement being made, with regard to the degree of exactness required.
   A. Precision
   B. Reliability
   C. Discrimination
   D. Accuracy

8. _______________ in metrology refers to the degree to which a measuring instrument divides the basic unit of length it is using for measurement.
   A. Precision
   B. Reliability
   C. Discrimination
   D. Accuracy

9. _______________ in metrology refers to the ability to obtain the desired result to the degree of precision required.
   A. Precision
   B. Reliability
   C. Discrimination
   D. Accuracy

10. The five categories of precision measurement are outside, inside, length, depth, and:
   A. Taper
   B. Rpm
   C. Thread
   D. Rms

TLD-E1
Understand Metrology Terms
Self-Assessment Answer Key

1. B
2. B
3. A
4. D
5. B
6. D
7. A
8. C
9. B
10. C

TLD-E2

TOOL & DIE and EDM SERIES

MASTER Technical Module No. TLD-E2

Subject: **Tool & Die and EDM** **Time: 4 Hrs.**

Duty: **Measure/Inspect**
Task: Select Measurement Tools

Objective(s):

Upon completion of this unit the student will be able to:
a. Identify basic semi-precision measuring tools;
b. Identify precision measuring tools;
c. Justify use of particular measurement tools based on tool characteristics;
d. Identify error possibilities in measurement tool selection; and,
e. Demonstrate proper care of precision measuring tools.

Instructional Materials:

MASTER Handout (TLD-E2-HO)
MASTER Laboratory Aid (TLD-E2-LA)
MASTER Self-Assessment
Steel Rules (metric and fractional)
0-1" micrometer
Assortment of outside (larger than 1") micrometers
1 set inside micrometers
1 depth micrometer set
1 ea. - outside spring caliper and inside spring caliper
6" dial calipers
1 ea. - Digital micrometer and digital vernier caliper
1 ea. - Set of telescoping gages and set of small hole gages
Examples of "go/no-go" gages

References:

Machine Tool Practices, Kibbe, Neely, and Meyer, Wiley Publishing, Latest Edition, "Dimensional Measurement"
NTMA Modules:
MA-I-05 "Steel Rules"
MA-I-09 "Steel Rules and Transfer Tools"
MA-I-13 "Micrometers"
MA-I-17 "Vernier Instruments

Student Preparation:

Students should have previously completed the following **MASTER** Technical Modules:

TLD-E1 "Understand Metrology Terms"

Introduction:

A person choosing to enter the technician trade is often surprised at the number of measuring tools available to such workers. With hundreds of these tools to choose from, the technician has a tool to cover almost any conceivable measuring situation. Often these tools are used alone or in combination with other measuring tools. As you begin your technician career, it is important that you learn to properly identify, use and care for these precision instruments.

Presentation Outline:

I. Describe and Discuss the Following Semi-Precision Measuring Tools
  A. Steel rules
  B. Calipers
  C. Squares
II. Describe and Discuss the Following Precision Measuring Tools
  A. Micrometers (outside, inside and depth)
  B. Verniers (calipers and height gage)
  C. Gages (small hole, telescope, fixed, and dial bore)
III. Justify Use of Particular Measurement Tools Based on Tool Characteristics
  A. What tolerance is required by the print?
  B. What physical characteristics of the part influence tool selection?
  C. What is the discrimination of the tool?
  D. How much time is available for part measurement/inspection?
  E. Will the tool be used by itself or in conjunction with some other tool?
  F. What is the most reliable tool for this application?
IV. Identify Error Possibilities in Measurement Tool Selection
  A. Part not being produced to specifications
  B. Too much time spent trying to measure correctly by not having the right tool
V. Demonstrate Proper Care of Precision Measuring Tools
  A. Storage
  B. Handling
  C. Cleaning

Practical Application:

Complete the Self-Assessment at the end of the chapters **in the text**.

Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-E3) dealing with measuring with hand held technician measuring instruments.

TLD-E2-HO
Select Measurement Tools
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Identify basic semi-precision measuring tools;
b. Identify precision measuring tools;
c. Justify use of particular measurement tools based on tool characteristics;
d. Identify error possibilities in measurement tool selection; and,
e. Demonstrate proper care of precision measuring tools.

Module Outline:

I. Describe and Discuss the Following Semi-Precision Measuring Tools
   A. Steel rules
   B. Calipers
   C. Squares
II. Describe and Discuss the Following Precision Measuring Tools
   A. Micrometers (outside, inside and depth)
   B. Verniers (calipers and height gage)
   C. Gages (small hole, telescope, fixed, and dial bore)
III. Justify Use of Particular Measurement Tools Based on Tool Characteristics
   A. What tolerance is required by the print?
   B. What physical characteristics of the part influence tool selection?
   C. What is the discrimination of the tool?
   D. How much time is available for part measurement/inspection?
   E. Will the tool be used by itself or in conjunction with some other tool?
   F. What is the most reliable tool for this application?
IV. Identify Error Possibilities in Measurement Tool Selection
   A. Part not being produced to specifications
   B. Too much time spent trying to measure correctly by not having the right tool
V. Demonstrate Proper Care of Precision Measuring Tools
   A. Storage
   B. Handling
   C. Cleaning

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

Name______________________________ Date_________________

TLD-E2
Select Measurement Tools
Self-Assessment

Circle the letter preceding the best answer.

1. A ________________ is a linear measuring instrument whose graduations represent real units of length .
   - A. Steel tape
   - B. Scale
   - C. Rule
   - D. Yardstick

2. A vernier caliper has two scales: the vernier scale and the__________________.
   - A. Top scale
   - B. Main scale
   - C. Principle scale
   - D. Inside scale

3. What is the discrimination for vernier instruments used for linear measurement?
   - A. .001"
   - B. .02mm
   - C. 1/64"
   - D. A and B above

4. How are metric scales usually graduated?
   - A. Meters
   - B. Feet and inches
   - C. Milliliters
   - D. MM and .5mm

5. The technician combination set includes 4 components: the steel rule, the protractor head, the square head, and ________________ .
   - A. Magnetic base
   - B. Protective cover
   - C. Center head
   - D. Adjustable depth gage

6. The vernier caliper may be used for inside measurement, outside measurement and _______________ .
   A. Diameter measurement
   B. Length measurement
   C. Depth measurement
   D. All of the above

7. Which of the following is not a valid type of micrometer?
   A. Outside micrometer
   B. Universal micrometer
   C. Thread micrometer
   D. Digital micrometer

8. Which of the following does the most harm to precision measuring tools?
   A. Heat
   B. Dirt
   C. Moisture
   D. Oil

9. A standard micrometer has a discrimination of what part of an inch?
   A. .0001"
   B. .001"
   C. .010"
   D. .100"

10. In order to be certain of the dimension when measuring with a micrometer: _________________ .
   A. Take at least one reading
   B. Take at least two readings
   C. Take at least three readings
   D. Take at least four readings

TLD-E2
Select Measurement Tools
Self-Assessment Answer Key

1. C

2. B

3. D

4. D

5. C

6. D

7. B

8. C

9. B

10. B

TOOL & DIE and EDM SERIES

MASTER Technical Module No. TLD-E3

Subject: **Tool & Die and EDM** **Time: 4 Hrs.**

Duty: **Measure/Inspect**
Task: Measure with Hand Held Instruments

Objective(s):

Upon completion of this unit the student will be able to:

a. Measure with steel rules (metric and inch);
b. Measure with micrometers;
c. Measure with comparison measuring instruments (e.g., calipers, telescope gages);
d. Measure with direct measuring instruments (e.g., vernier, dial and digital instruments); and,
e. Measure with fixed gages (go and no-go gages).

Instructional Materials:

MASTER Handout (TLD-E3-HO)
MASTER Laboratory Exercise (TLD-E3-LE1)
MASTER Laboratory Exercise (TLD-E3-LE2)
MASTER Laboratory Aid (TLD-E3-LA)
Steel Rules (metric and fractional) for each student or group of students
0-1" micrometers for each student or group of students
Assortment of outside (larger than 1") micrometers
1 set inside micrometers
1 depth micrometer set
1 ea. - outside spring caliper and inside spring caliper
6" dial calipers for each student or group of students
Random collection of objects for student practice
1 ea. - Digital micrometer and digital vernier caliper
1 ea. - Set of telescoping gages and set of small hole gages
Examples of "go/no-go" gages

References:

Machine Tool Practices, Kibbe, Neely, and Meyer, Wiley Publishing, Latest Edition, "Dimensional Measurement"
NTMA Modules:
MA-I-05 "Steel Rules"

MA-I-09	"Steel Rules and Transfer Tools"
MA-I-13	"Micrometers"
MA-I-17	"Vernier Instruments"

Student Preparation:

Students should have previously completed the following **MASTER** Technical Modules:

TLD-E1	"Understand Metrology Terms"
TLD-E2	"Select Measurement Tools"

Introduction:

Every aspect of our lives, from the clothes we wear to the cars we drive, is greatly influenced by measurement. For the technician, measurement is especially important since it is the technician who is responsible for crafting the tools, fixtures, and components which make up or support virtually every part of our lives. Therefore, it is essential for the technician to be a master in the use of not only the machine tools, but also the instruments which are used to measure the precision components demanded by consumers today. One of the most valuable assets you can possess is the expert use of the technician measuring tools and a desire to practice quality consciousness in every aspect of your job performance.

Presentation Outline:

I. Discuss the Importance of Learning and Practicing Proper Measurement Techniques
    A. Show the video "Measuring Tools"
    B. Give each student a copy of the handout "Proper Measuring Techniques"
II. Discuss and Demonstrate Proper Measurement Techniques Using the Steel Rule
III. Discuss and Demonstrate the Use of Micrometer Type Measuring Instruments
    A. Outside micrometers
    B. Inside micrometers
    C. Depth micrometers
    D. Practice and demonstration of skills listed above
IV. Discuss and Demonstrate the Use of Transfer Type Measuring Instruments
    A. Spring calipers (inside and outside)
    B. Telescope gages
    C. Small hole gages
    D. Practice and demonstration of skills listed above
V. Discuss and Demonstrate the Use of Direct Measuring Instruments

- A. Vernier calipers
- B. Dial calipers
- C. Digital calipers
- D. Practice and demonstration of skills listed above

VI. Discuss the Purpose of Fixed Gages and Demonstrate Their Use
- A. Cylindrical plug and ring gages
- B. Taper plug and ring gages
- C. Snap gages
- D. Thread plug gages
- E. Practice and demonstration of skills listed above

VII. Complete Practical Exercises (TLD-E3-LE1) and (TLD-E3-LE2) On All the Above Material

Practical Application:

Students will practice in the lab with each measuring instrument and complete the Laboratory Worksheet (TLD-E3-LW) and turn it in to the instructor for evaluation.

Evaluation and/or Verification:

Given:	All the measuring instruments listed in the "Instructional Materials" and appropriate sample workpieces to measure;
The student will:	Study the material as presented by the instructor, evaluate his/her skills through the Self-Assessment, and demonstrate those skills through the Laboratory Worksheet.

The standards of skill performance are that the student will:

1. Score 90% on the Self-Assessment;
2. Measure with the steel rule to an accuracy of ±1/64 inch;
3. Measure with the micrometer to an accuracy of ±0.001 inch;
4. Measure with the dial and digital caliper to an accuracy of ±0.001 inch; and,
5. Determine whether the holes, tapers, and threads are within acceptable limits by use of the appropriate go/no-go gages.

Summary:

Review the main lesson points. Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-E4) dealing with eliminating variables which affect accurate measurement.

TLD-E3-HO
Measure With Hand Held Instruments
Attachment 1: **MASTER** Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Measure with steel rules (metric and inch);
b. Measure with micrometers;
c. Measure with comparison measuring instruments (e.g., calipers, telescope gages);
d. Measure with direct measuring instruments (e.g., vernier, dial and digital instruments); and,
e. Measure with fixed gages (go and no-go gages).

Module Outline:

I. Discuss the Importance of Learning and Practicing Proper Measurement Techniques
  A. Show the video "Measuring Tools"
  B. Give each student a copy of the handout "Proper Measuring Techniques"
II. Discuss and Demonstrate Proper Measurement Techniques Using the Steel Rule
III. Discuss and Demonstrate the Use of Micrometer Type Measuring Instruments
  A. Outside micrometers
  B. Inside micrometers
  C. Depth micrometers
  D. Practice and demonstration of skills listed above
IV. Discuss and Demonstrate the Use of Transfer Type Measuring Instruments
  A. Spring calipers (inside and outside)
  B. Telescope gages
  C. Small hole gages
  D. Practice and demonstration of skills listed above
V. Discuss and Demonstrate the Use of Direct Measuring Instruments
  A. Vernier calipers
  B. Dial calipers
  C. Digital calipers
  D. Practice and demonstration of skills listed above
VI. Discuss the Purpose of Fixed Gages and Demonstrate Their Use
  A. Cylindrical plug and ring gages
  B. Taper plug and ring gages
  C. Snap gages
  D. Thread plug gages
  E. Practice and demonstration of skills listed above

VII. **Complete Practical Exercise (TLD-E3-LE1) and (TLD-E3-LE2) On All the Above Material**

Name:________________ Date:______________________

TLD-E3-LE1

Measure With Hand Held Instruments

Attachment 2: **MASTER** Laboratory Exercise No. 1

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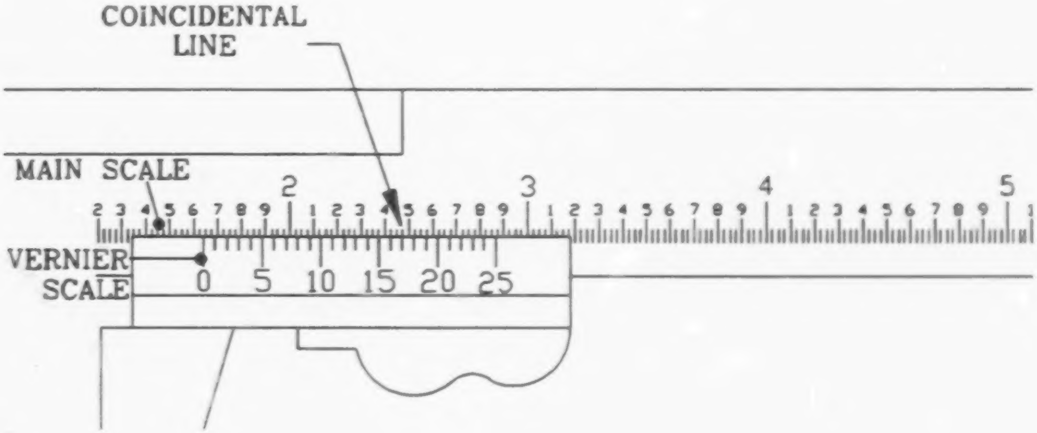
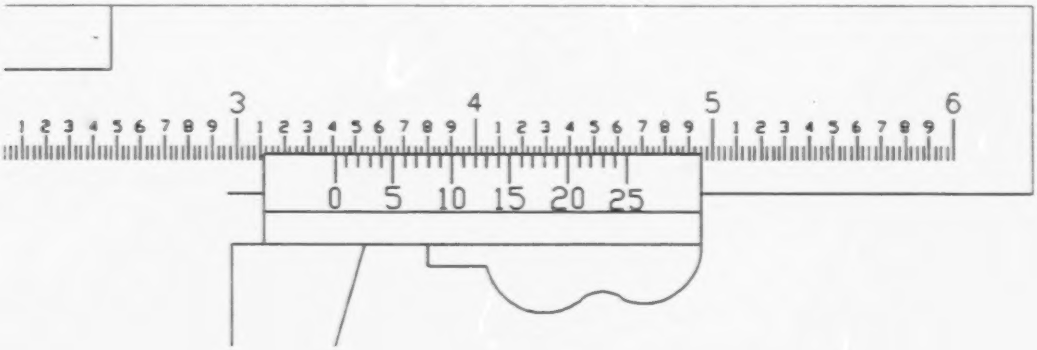
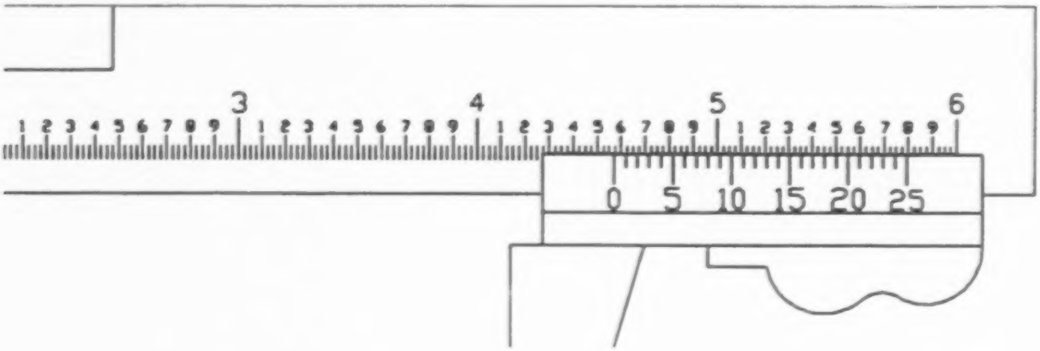
1. What is the reading on the vernier caliper below?
    - a. .642
    - b. 1.642
    - c. 1.645
    - d. 1.64


COINCIDENTAL LINE
MAIN SCALE
VERNIER SCALE
2
3
4
5
2 3 4 5 6 7 8 9 1 2 3 4 5 6 7 8 9 1 2 3 4 5 6 7 8 9 1 2 3 4 5 6 7 8 9 1
0 5 10 15 20 25

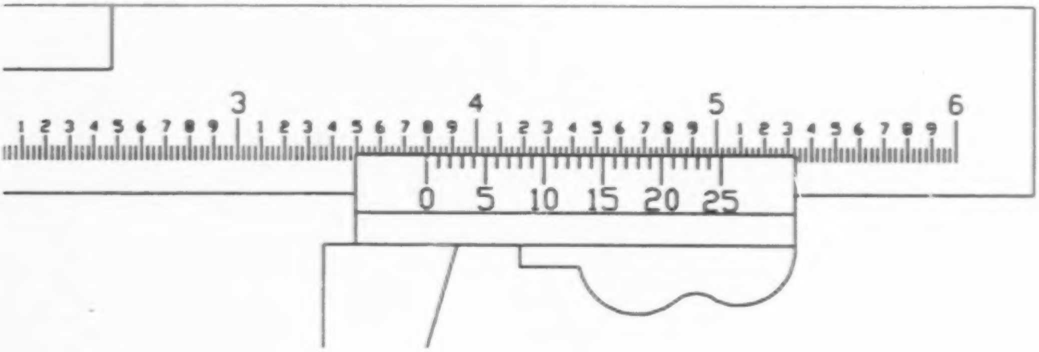
2. What is the reading on the vernier caliper below?
    - a. .415
    - b. 3.125
    - c. 3.405
    - d. 3.412


3
4
5
6
1 2 3 4 5 6 7 8 9 1 2 3 4 5 6 7 8 9 1 2 3 4 5 6 7 8 9 1 2 3 4 5 6 7 8 9
0 5 10 15 20 25

3. What is the reading on the vernier caliper below?
   a. 4.575
   b. 4.250
   c. 4.570
   d. 4.275


3
4
5
6
1 2 3 4 5 6 7 8 9
0 5 10 15 20 25

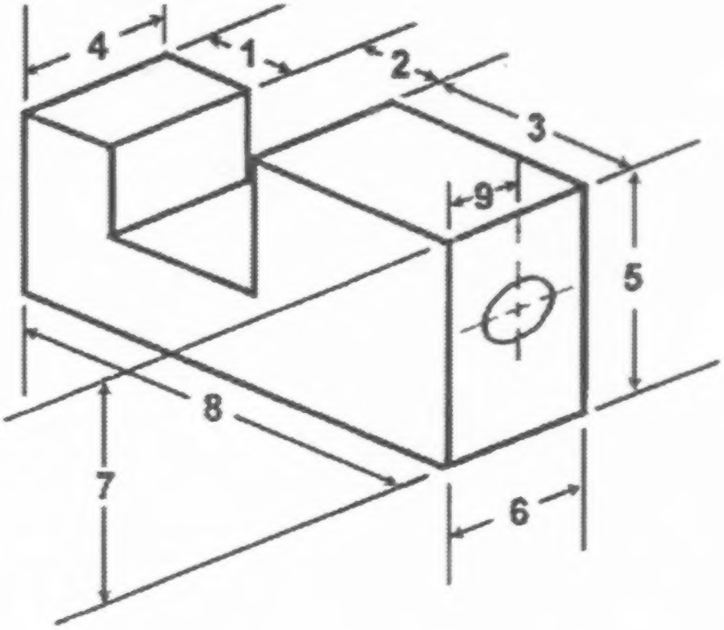
4. What is the reading on this vernier caliper?
   a. 3.785
   b. 3.800
   c. 3.473
   d. 3.793


3
4
5
6
1 2 3 4 5 6 7 8 9
0 5 10 15 20 25

Name____________________________ Date________________

TLD-E3-LE2
Measure With Hand Held Instruments
Attachment 3: **MASTER** Laboratory Exercise No. 2

Using the measuring instruments provided for you and the measuring specimens, measure for the following dimensions and record your answers in the space provided. Be sure to provide metric and inch answers for each dimension. Turn this sheet in to your instructor for evaluation.



Specimen Number _______

Dimension	metric	inch	Dimension	metric	inch
1.	_____	_____	7.	_____	_____
2.	_____	_____	8.	_____	_____
3.	_____	_____	9.	_____	_____
4.	_____	_____	10.	_____	_____
5.	_____	_____	11.	_____	_____
6.	_____	_____			

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    - a. No loose clothing, including ties;
    - b. Long hair properly stowed;
    - c. No jewelry;
    - d. Hard, closed-toe shoes;
    - e. Eye protection (safety glasses); and
    - f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

TLD-E4

TOOL & DIE and EDM SERIES
MASTER Technical Module No. TLD-E4

Subject: **Tool & Die and EDM** **Time: 4 Hrs.**

Duty: **Measure/Inspect**
Task: Eliminate Measurement Variables

Objective(s):

Upon completion of this unit the student will be able to:

a. Discuss factors affecting accurate measurement (dirt, temperature, improper measuring tool calibration);
b. Explain calibration requirements of various precision instruments;
c. Illustrate measurement differences when taken with calibrated and non-calibrated instruments; and,
d. Calibrate a micrometer type measuring tool.

Instructional Materials:

MASTER Handout (TLD-E4-HO)
MASTER Laboratory Exercise (TLD-E4-LE)
MASTER Laboratory Aid (TLD-E4-LA)
MASTER Self-Assessment
Assortment of outside micrometers with standards and adjusting wrench
Dial calipers with adjustment tool
Set of gage blocks

References:

Machine Tool Practices, Kibbe, Neely, and Meyer, Wiley Publishing, Latest Edition, "Dimensional Measurement"

Student Preparation:

Students should have previously completed the following **MASTER** Technical Modules:

TLD-E1 "Understand Metrology Terms"
TLD-E2 "Select Measurement Tools"
TLD-E3 "Measure With Hand Held Instruments"

Introduction:

Simply possessing the finest measuring tools that money can buy does not insure precision measurement. Many other factors affect accurate measurement. The technician must learn how to prepare the surface for measurement, how to manipulate the measuring tools correctly, and how to check the calibration of those measuring tools. All of these things are important if the technician is to consistently make accurate measurements.

Presentation Outline:

I. Discuss Factors Affecting Accurate Measurement
    A. Tool selection
    B. Cleanliness
    C. Temperature
    D. Calibration
    E. "Feel"
II. Explain Calibration Requirements of Various Precision Instruments
    A. Individual responsibility vs. company responsibility
    B. Calibration standards
III. Illustrate Measurement Differences When Taken With Calibrated and Non-Calibrated Instruments
IV. Calibrate a Micrometer Type Measuring Tool
    A. 5 steps adjusting an outside micrometer which needs adjustment
        1. Clean the measuring faces of the micrometer
        2. Close the measuring faces carefully against the standard by turning the ratchet stop or friction thimble
        3. Insert the C-spanner into the hole or slot provided in the sleeve
        4. Carefully turn the sleeve until the index line on the sleeve coincides with the zero line on the thimble
        5. Recheck the accuracy of the micrometer by opening and then closing the micrometer faces by turning the ratchet stop or friction thimble
    B. Student practice of the above procedure

Practical Application:

Students will clean, check and calibrate an outside micrometer.

Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-E5) on the subject of performing measurements and inspections using a surface plate and accessories

TLD-E4-HO
Eliminate Measurement Variables
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Discuss factors affecting accurate measurement (dirt, temperature, improper measuring tool calibration);
b. Explain calibration requirements of various precision instruments;
c. Illustrate measurement differences when taken with calibrated and non-calibrated instruments; and,
d. Calibrate a micrometer type measuring tool.

Module Outline:

I. Discuss Factors Affecting Accurate Measurement
  A. Tool selection
  B. Cleanliness
  C. Temperature
  D. Calibration
  E. "Feel"
II. Explain Calibration Requirements of Various Precision Instruments
  A. Individual responsibility vs. company responsibility
  B. Calibration standards
III. Illustrate Measurement Differences When Taken With Calibrated and Non-Calibrated Instruments
IV. Calibrate a Micrometer Type Measuring Tool
  A. 5 steps adjusting an outside micrometer which needs adjustment
    1. Clean the measuring faces of the micrometer
    2. Close the measuring faces carefully against the standard by turning the ratchet stop or friction thimble
    3. Insert the C-spanner into the hole or slot provided in the sleeve
    4. Carefully turn the sleeve until the index line on the sleeve coincides with the zero line on the thimble
    5. Recheck the accuracy of the micrometer by opening and then closing the micrometer faces by turning the ratchet stop or friction thimble
  B. Student practice of the above procedure

TLD-E4-LE
Eliminate Measurement Variables
Attachment 2: MASTER Laboratory Exercise

The student will perform the following:

1. Calibrate a micrometer by:
   - a. Adjusting micrometer;
   - b. Cleaning the measuring faces of the micrometer;
   - c. Closing the measuring faces carefully against the standard by turning the ratchet stop or friction thimble;
   - d. Inserting the C-spanner into the hole or slot provided in the sleeve;
   - e. Carefully turning the sleeve until the index line on the sleeve coincides with the zero line on the thimble; and,
   - f. Rechecking the accuracy of the micrometer by opening and then closing the micrometer faces by turning the ratchet stop or friction thimble.

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and,
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

Name____________________________ Date________________

TLD-E4
Eliminate Measurement Variables
Self-Assessment

Write the answers to the following questions in the space provided.

1. List 5 factors which may affect accurate measurement.

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2. Briefly explain why some companies place the burden of calibration on the technician while other companies employ persons to calibrate the tools and instruments of the technician.

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3. Even though standards are furnished with many outside micrometers, what is generally considered to the best standard to use for calibration of technician measuring instruments?

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____

4. **Why are many inspection/quality control stations located in climate controlled areas?**

____

____

____

5. **List the steps (in order) to follow should the accuracy of a micrometer require adjustment.**

1. ____

____

2. ____

____

3. ____

____

4. ____

____

5. ____

____

TOOL & DIE and EDM SERIES
MASTER Technical Module No. TLD-E5

Subject: **Tool & Die and EDM** **Time: 8 Hrs.**

Duty: **Measure/Inspect**
Task: Measure/Inspect Using Surface Plate and Accessories

Objective(s):

Upon completion of this unit the student will be able to:

a. Describe care of surface plate;
b. Use surface plate accessories correctly (sine bar, gage blocks, etc.);
c. Check for part squareness;
d. Check part dimensions for accuracy; and,
e. Align workpieces using height gage and dial indicators.

Instructional Materials:

MASTER Handout (TLD-E5-HO)
MASTER Laboratory Exercise (TLD-E5-LE)
MASTER Laboratory Aid (TLD-E5-LA)
MASTER Self-Assessment
Surface plate and accessories
Parts to check

References:

Machine Tool Practices, Kibbe, Neely, and Meyer, Wiley Publishing, Latest Edition, "Layout"

Student Preparation:

Students should have previously completed the following **MASTER** Technical Modules:

TLD-E1	"Understand Metrology Terms"
TLD-E2	"Select Measurement Tools"
TLD-E3	"Measure With Hand Held Instruments"
TLD-E4	"Eliminate Measurement Variables"

Introduction:

Much of the measuring that a technician performs is done at various points during the processing of the workpiece. Whenever a higher degree of precision is required or whenever the work has been removed from the machine, the work is often subjected to inspection. This inspection process is frequently accomplished on a surface plate using a set of accessories which are specifically for use with the surface plate. This lesson will cover the use of the surface plate and the accessories which are used for layout and inspection purposes.

Presentation Outline:

I. Describe Types of Surface Plate and Surface Tables
  A. Cast iron and semi-steel surface plates
  B. Granite surface plate
II. Discuss the Different Surface Plate Accessories and Their Use
  A. Sine bar
  B. Gage blocks
  C. Vernier height gage
  D. Precision height gage
  E. Dial test indicator
  F. Squares
  G. Angle plate and clamps
  H. 1,2,3 blocks
III. Demonstrate Checking For Part Squareness
IV. Demonstrate Checking Part Dimensions For Accuracy
V. Demonstrate Aligning Workpieces Using Height Gage and Dial Indicators

Practical Application:

Students will complete assignments using a surface plate, gage blocks, sine bar, and other accessories normally used in conjunction with the surface plate.

Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this lesson

Summary:

Review the main lesson points and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-E6) dealing with the use of stationary equipment for inspection purposes.

TLD-E5-HO
Measure/Inspect Using Surface Plate and Accessories
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:
- a. Describe care of surface plate;
- b. Use surface plate accessories correctly (sine bar, gage blocks, etc.);
- c. Check for part squareness;
- d. Check part dimensions for accuracy; and,
- e. Align workpieces using height gage and dial indicators.

Module Outline:

- I. Describe Types of Surface Plate and Surface Tables
  - A. Cast iron and semi-steel surface plates
  - B. Granite surface plate
- II. Discuss the Different Surface Plate Accessories and Their Use
  - A. Sine bar
  - B. Gage blocks
  - C. Vernier height gage
  - D. Precision height gage
  - E. Dial test indicator
  - F. Squares
  - G. Angle plate and clamps
  - H. 1,2,3 blocks
- III. Demonstrate Checking For Part Squareness
- IV. Demonstrate Checking Part Dimensions For Accuracy
- V. Demonstrate Aligning Workpieces Using Height Gage and Dial Indicators

Measure/Inspect Using Surface Plate and Accessories
Attachment 2: MASTER Laboratory Exercise

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1. Instructor will provide sample mechanical parts for students to:
   a. Demonstrate checking for part squareness;
   b. Demonstrate checking part dimensions for accuracy; and,
   c. Demonstrate aligning workpieces using height gage and dial indicators.

2. Students will practice:
   a. Checking for part squareness;
   b. Checking part dimensions for accuracy; and,
   c. Aligning workpieces using height gage and dial indicators.

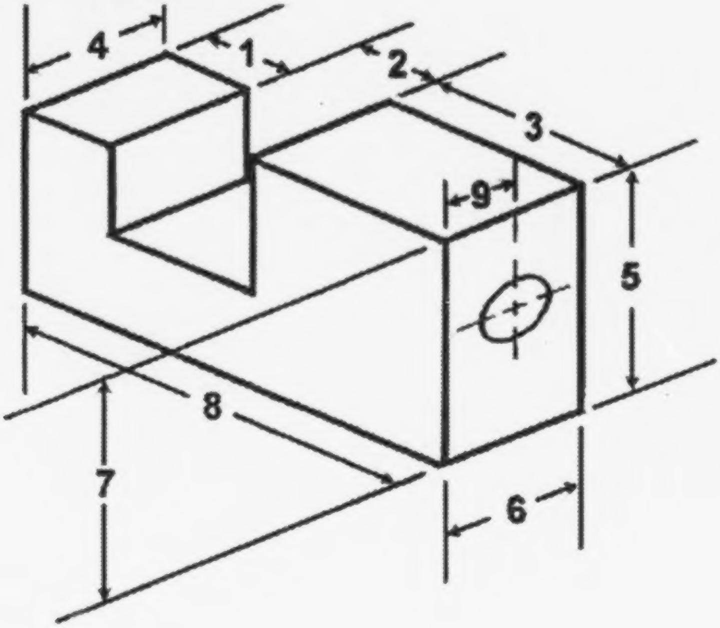
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

Name______________________________ Date_________________

TLD-E5
Measure/Inspect Using Surface Plate and Accessories
Self-Assessment

Using the measuring instruments provided for you and the measuring specimens, measure for the following dimensions and record your answers in the space provided. Be sure to provide metric and inch answers for each dimension. Turn this sheet in to your instructor for evaluation.



Dimension	metric	inch	Dimension	metric	inch
1.	____	____	11.	____	____
2.	____	____	12.	____	____
3.	____	____	13.	____	____
4.	____	____	14.	____	____
5.	____	____	15.	____	____

6. _____ _____

7. _____ _____

8. _____ _____

9. _____ _____

10. _____ _____

16. _____ _____

17. _____ _____

18. _____ _____

19. _____ _____

20. _____ _____

TOOL & DIE and EDM SERIES

MASTER Technical Module No. TLD-E6

Subject:	**Tool & Die and EDM**	**Time: 12 Hrs.**
Duty:	**Measure/Inspect**	
Task:	Inspect Using Stationary Equipment	

Objective(s):

Upon completion of this unit the student will be able to:
a. Set up and use an Optical Comparator; and,
b. Set up and use a Coordinate Measuring Machine (CMM).

Instructional Materials:

MASTER Handout (TLD-E6-HO)
MASTER Laboratory Exercise (TLD-E6-LE)
MASTER Laboratory Aid (TLD-E6-LA)
MASTER Self-Assessment
Optical Comparator
Coordinate Measuring Machine
Samples for Measurement

References:

Machine Tool Practices, Kibbe, Neely, and Meyer, Wiley Publishing, Latest Edition
Instructor's Manual, Machine Tool Practices, Kibbe, Neely, and Meyer, Wiley Publishing, Latest Edition
Workbook for Machining Fundamentals, John R. Walker, The Goodheart-Willcox Company, Inc. Publishing, Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:

TLD-E1	"Understand Metrology Terms"
TLD-E2	"Select Measurement Tools"
TLD-E3	"Measure With Hand Held Instruments"
TLD-E4	"Eliminate Measurement Variables"
TLD-E5	"Measure/Inspect Using Surface Plate and Accessories"

Introduction:

Today's manufacturing processes require much higher degrees of precision. Many components are also manufactured at one location then shipped to another for assembly. These factors have caused the technician to rely more and more on measuring and inspecting instruments with higher degrees of precision. Free standing inspection devices such as the optical comparator and the coordinate measuring machine (CMM) are being used to help the technician maintain the high levels of precision required by manufacturers and consumers alike.

Presentation Outline:

I. Define the Term "Comparison Measurement"
    A. Describe the following comparison instruments:
        1. Dial indicator
        2. Mechanical comparator
        3. Optical comparator
        4. Mechanical-optical comparator
        5. Air gages
        6. Electronic comparator
    B. Demonstrate the setup and operation of the optical comparator
    C. Allow students to practice setup and operation of the optical comparator
II. Discuss the Advantages of Measuring with the Coordinate Measuring Machine (CMM)
    A. Demonstrate the setup and operation of the CMM
    B. Allow students to practice setup and operation of the CMM

Practical Application:

Students will complete assignments using the optical comparator and the coordinate measuring machine.

Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-F1) dealing with metal cutting and metal cutting tools.

TLD-E6-HO
Inspect Using Stationary Equipment
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Set up and use an Optical Comparator; and,

b. Set up and use a Coordinate Measuring Machine (CMM).

Module Outline:

- I. Define the Term "Comparison Measurement"
  - A. Describe the following comparison instruments:
    - 1. Dial indicator
    - 2. Mechanical comparator
    - 3. Optical comparator
    - 4. Mechanical-optical comparator
    - 5. Air gages
    - 6. Electronic comparator
  - B. Demonstrate the setup and operation of the optical comparator
  - C. Allow students to practice setup and operation of the optical comparator
- II. Discuss the Advantages of Measuring with the Coordinate Measuring Machine (CMM)
  - A. Demonstrate the setup and operation of the CMM
  - B. Allow students to practice setup and operation of the CMM

TLD-E6-LE
Inspect Using Stationary Equipment
Attachment 2: MASTER Laboratory Exercise

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1. The instructor will:
   a. Demonstrate the setup and operation of the optical comparator; and,
   b. Demonstrate the setup and operation of the Coordinate Measuring Machine (CMM).

2. The students will:
   a. Practice the setup and operation of the optical comparator; and,
   b. Practice the setup and operation of the Coordinate Measuring Machine (CMM).

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and,
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

Name______________________________ Date________________

TLD-E6
Inspect Using Stationary Equipment
Self-Assessment

Circle the letter preceding the best answer.

1. The CMM measures workpieces in ___ dimensions.
   - A. One
   - B. Two
   - C. Three
   - D. Four
   - E. None of the above answers is correct.

2. Optical comparators project a ___ shadow of the object.
   - A. Magnified
   - B. True size
   - C. Miniaturized
   - D. Any of the above answers could be correct, depending on how the technician sets up the comparator.
   - E. None of the above answers is correct.

3. Which of the following *cannot* be checked using the optical comparator?
   - A. Screw threads
   - B. Gears
   - C. Cutting tools
   - D. All of the above are normally checked with optical comparators.
   - E. None of the above answers is correct.

4. The optical comparator often uses ___ to check the workpiece.
   - A. Ideal models
   - B. Templates
   - C. Photographs
   - D. All of the above are used with the comparator.
   - E. None of the above answers is correct.

5. The CMM is useful for checking ___ among parts.
   - A. Relative locations
   - B. Relative sizes
   - C. Relative weights
   - D. All of the above answers are correct.
   - E. None of the above answers is correct.

TLD-E6
Inspect Using Stationary Equipment
Self-Assessment Answer Key

1.	C
2.	A
3.	D
4.	B
5.	A

TOOL AND DIE MAKER .... skilled workers who produce tools, dies, and special guiding and holding devices that are used in machining.

	Duties	Tasks												
A	Practice Safety	A-1 Follow safety manuals and all safety regulations/ requirements	A-2 Maintain safe equipment and machinery	A-3 Use safe operating procedures for hand and machine tools	A-4 Maintain a clean and safe work environment	A-5 Use safe material handling practices	A-6 Consult and apply MSDS for hazards of various materials							
B	Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Perform basic algebraic operations	B-3 Use basic geometric principles	B-4 Perform basic trigonometric functions	B-5 Use and apply Cartesian Coordinate System								
C	Interpret Engineering Drawings and Related Documents	C-1 Interpret and understand basic layout/types of drawings	C-2 Interpret, review, and apply blueprint notes, dimensions, and tolerances	C-3 Use and apply Geometric Dimensioning and Tolerancing (GD&T)	C-4 Demonstrate traditional mechanical drafting and sketching techniques	C-5 Understand and use quality systems								
D	Demonstrate Knowledge of Manufacturing Materials	D-1 Identify materials with desired properties	D-2 Identify materials and processes to produce a part	D-3 Discuss classification systems for metal										
E	Measure/ Inspect	E-1 Understand metrology terms	E-2 Select measurement tools	E-3 Measure with hand held instruments	E-4 Eliminate measurement variables	E-5 Measure/inspect using surface plate and accessories	E-6 Inspect using stationary equipment							
F	Demonstrate Knowledge of Manufacturing Processes	F-1 Discuss metal cutting and metal cutting tools	F-2 Operate metal saws	F-3 Operate drill presses and tooling	F-4 Operate engine and turret lathes and tooling	F-5 Operate vertical and horizontal mills and tooling	F-6 Operate precision grinders	F-7 Operate heat treating equipment and processes	F-8 Operate sheet metal equipment	F-9 Operate welding equipment and processes	F-10 Estimate time required/ cost to produce a part			
G	Use Computers	G-1 Use computer operating systems	G-2 Understand computer terminology	G-3 Use file management systems	G-4 Install and use software packages									
H	Perform CAD/ CAM and CNC Programming Tasks	H-1 Discuss fundamentals of CNC machines and controls	H-2 Program and operate CNC milling machine and machining center	H-3 Program and operate CNC lathe	H-4 Use Computer-Aided Drafting (CAD) system	H-5 Create 3-D solid models	H-6 Use Computer-Aided Manufacturing (CAM) system							
I	Perform Tool and Die Making Operations	I-1 Discuss basic types and functions of jigs and fixtures	I-2 Utilize concepts of jig and fixture design	I-3 Demonstrate understanding of different types of industrial dies	I-4 Utilize basic die theory	I-5 Utilize principles of die design	I-6 Perform tool and die repair	I-7 Demonstrate tool and die making skills						
J	Operate Electrical Discharge Machine (EDM)	J-1 Discuss fundamentals of EDM	J-2 Setup and operate conventional sinker EDM	J-3 Program, setup, and operate CNC sinker EDM and EDM drill	J-4 Program, setup, and operate CNC wire EDM									

TOOL & DIE and EDM SERIES

MASTER Technical Module No. TLD-F1

Subject: **Tool & Die and EDM** **Time: 10 Hrs.**

Duty: **Demonstrate Knowledge of Manufacturing Processes**
Task: Discuss Metal Cutting and Metal Cutting Tools

Objective(s):

Upon completion of this unit the student will be able to:

a. Discuss physics of metal cutting
b. Discuss cutting tools
c. Discuss cutting fluids and coolants
d. Select appropriate tooling for application

Instructional Materials:

MASTER Handout (TLD-F1-HO)
MASTER Self-Assessment

References:

Technology of Machine Tools, Steve Krar and Albert Check, Glencoe Publishing, Latest Edition
Machine Tool and Manufacturing Technology, Krar, Rapisarda, and Check, Delmar Publishers, Latest Edition
NTMA Machinist Training Program Module(s), National Tooling and Machining Association, 9399 Livingston Road, Fort Washington, MD 20744, Latest Edition
Instructor's Guide, Technology of Machine Tools, Amand, Krar, and Oswald, McGraw-Hill Publishers, Latest Edition
Workbook for Technology of Machine Tools, Amand, Krar, and Oswald, McGraw-Hill Publishers, Latest Edition
Modern Metalworking, John R. Walker , Goodheart-Willcox, Latest Edition
Metalwork; Technology and Practice, Victor E. Repp, Glencoe Publishing, Latest Edition
Machining Fundamentals, John R. Walker , Goodheart-Willcox, Latest Edition
Fundamentals of Machine Tool Technology and Manufacturing Processes, C. Thomas Olivo, Delmar Publishing, Latest Edition

Advanced Machine Tool Technology and Manufacturing Processes, C. Thomas Olivo, Delmar, Latest Edition

Application of Metal Cutting Theory, Fryderyk E. Gorczyca, Industrial Press, Latest Edition

Video(s): ***Single Point Cutting Tools***, 21min.VHS, National Tooling and Machining Association

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Student Preparation:

Students should have previously completed the following Technical Modules:

TLD-A1 through TLD-A6	"Practice Safety
TLD-B1 through TLD-B5	"Apply Mathematical Concepts"
TLD-D1 through TLD-D3	"Demonstrate Knowledge of Manufacturing Materials"

Introduction:

Many times students of metal trades learn to simply operate machines, rather than to cut metal.

Before a student becomes proficient as a machinist or tool maker, it is imperative that he/she have an understanding of what takes place when the cutting tool contacts the workpiece. Although many successful technicians have had no formal training in the physics of metal cutting, they apply empirical knowledge with each setup. It is important that students be taught the fundamentals about metal cutting and metal cutting tools in order to make knowledgeable decisions regarding the machining process. This module is not intended to replace helpful charts and manuals that technicians use to aid in setup, cutting speeds and feeds, tool geometry, etc., but will give students the foundation to build upon as they again experience in the machine shop.

Presentation Outline:

I. Discuss Physics of Metal Cutting
   A. Explain the metal cutting process
   B. Define metal cutting terms
      1. Built-up edge
      2. Chip-tool interface
      3. Crystal elongation
      4. Deformed zone
      5. Plastic deformation
      6. Plastic flow
      7. Rupture
      8. Shear angle (plane)

        9. Shear zone
        10. Cutting force
        11. Feed force
        12. Cutting Speed
            a. Surface feet per minute (SFM)
            b. Revolutions per minute (RPM)
        13. Feed
    C. Discuss machinability of metals
        1. Low-carbon steel
        2. High-carbon steel
        3. Tool steel
        4. Alloys
        5. Cast iron
    D. Discuss chip formation
        1. Discontinuous
        2. Continuous
        3. Continuous with built-up edge

II. Discuss Cutting Tools
    A. Geometry
        1. Front, or end, relief (clearance)
        2. Side relief
        3. Side cutting edge angle
        4. Nose radius
        5. Side rake angle
        6. Back rake angle
    B. Materials
        1. High-speed tool steel
        2. Cemented carbide
            a. Brazed-tip
            b. Indexable disposable inserts
            c. Coated
        3. Ceramic
        4. Diamond
    C. ANSI insert identification system
    D. Discuss factors that affect tool life
        1. Type material being cut
        2. Microstructure of the material
        3. Hardness of the material
        4. Surface condition of the material
        5. Cutting tool material
        6. Profile of the cutting tool
        7. Type machining operation being performed
        8. Speed, feed, and depth of cut
        9. Effectiveness of cutting fluid
    E. Discuss grinding single-point tools

III. Discuss Cutting Fluids and Coolants
    A. Function
        1. Coolant
        2. Lubricant
        3. Prolong tool life
        4. Control rust
    B. Types
        1. Cutting oils
        2. Soluble oils
        3. Chemical fluids
    C. Desirable characteristics
        1. Good cooling capacity
        2. Good lubricating qualities
        3. Rust resistance
        4. Stability (long life)
        5. Resistance to rancidity
        6. Nontoxic
        7. Transparent
        8. Relatively low viscosity
        9. Nonflammable
    D. Application
        1. Flood method
        2. Mist method
        3. Coolant-fed tooling
IV. Discuss the Selection of Appropriate Tooling for an Application
    A. Tool geometry
    B. Tool material
    C. Cutting fluids

Practical Application:

Students should be given demonstrations of metal cutting operations to emphasize points introduced in lecture. Students should also be given projects to grind single-point tool bits for turning and threading.

Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-F2) dealing with operation of metal saws.

TLD-F1-HO
Discuss Metal Cutting and Metal Cutting Tools
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

- a. Discuss physics of metal cutting
- b. Discuss cutting tools
- c. Discuss cutting fluids and coolants
- d. Select appropriate tooling for application

Module Outline:

- I. Discuss Physics of Metal Cutting
  - A. Explain the metal cutting process
  - B. Define metal cutting terms
    - 1. Built-up edge
    - 2. Chip-tool interface
    - 3. Crystal elongation
    - 4. Deformed zone
    - 5. Plastic deformation
    - 6. Plastic flow
    - 7. Rupture
    - 8. Shear angle (plane)
    - 9. Shear zone
    - 10. Cutting force
    - 11. Feed force
    - 12. Cutting Speed
      - a. Surface feet per minute (SFM)
      - b. Revolutions per minute (RPM)
    - 13. Feed
  - C. Discuss machinability of metals
    - 1. Low-carbon steel
    - 2. High-carbon steel
    - 3. Tool steel
    - 4. Alloys
    - 5. Cast iron
  - D. Discuss chip formation
    - 1. Discontinuous
    - 2. Continuous
    - 3. Continuous with built-up edge
- II. Discuss Cutting Tools
  - A. Geometry

        1. Front, or end, relief (clearance)
        2. Side relief
        3. Side cutting edge angle
        4. Nose radius
        5. Side rake angle
        6. Back rake angle
    B. Materials
        1. High-speed tool steel
        2. Cemented carbide
            a. Brazed-tip
            b. Indexable disposable inserts
            c. Coated
        3. Ceramic
        4. Diamond
    C. ANSI insert identification system
    D. Discuss factors that affect tool life
        1. Type material being cut
        2. Microstructure of the material
        3. Hardness of the material
        4. Surface condition of the material
        5. Cutting tool material
        6. Profile of the cutting tool
        7. Type machining operation being performed
        8. Speed, feed, and depth of cut
        9. Effectiveness of cutting fluid
    E. Discuss grinding single-point tools
III. Discuss Cutting Fluids and Coolants
    A. Function
        1. Coolant
        2. Lubricant
        3. Prolong tool life
        4. Control rust
    B. Types
        1. Cutting oils
        2. Soluble oils
        3. Chemical fluids
    C. Desirable characteristics
        1. Good cooling capacity
        2. Good lubricating qualities
        3. Rust resistance
        4. Stability (long life)
        5. Resistance to rancidity
        6. Nontoxic
        7. Transparent
        8. Relatively low viscosity

    9. Nonflammable
  D. Application
    1. Flood method
    2. Mist method
    3. Coolant-fed tooling
IV. Discuss the Selection of Appropriate Tooling for an Application
  A. Tool geometry
  B. Tool material
  C. Cutting fluids

Name______________________________ Date________________

TLD-F1
Discuss Metal Cutting and Metal Cutting Tools
Self-Assessment

1. The layer of compressed metal from the material being cut which adheres to and piles up on the cutting tool edge during a machining operation is the:
   - a. Compression
   - b. Built-up edge
   - c. Rupture
   - d. Rake angle

2. That portion of the face of the cutting tool upon which the chip slides as it is cut from the metal is the:
   - a. Chip-tool interface
   - b. Tool face
   - c. Side rake
   - d. Chip face

3. Crystal elongation is:
   - a. The ability of the metal to crystallize during machining
   - b. The distortion of the crystal structure of the material during a machining operation
   - c. The elongation of the crystal structure of the cutting tool
   - d. The desired effect of machining crystal

4. The area in which the work material is being deformed during a cutting action is the:
   - a. Shear zone
   - b. Deformed zone
   - c. Distortion zone
   - d. Error zone

5. The area where plastic deformation of metal occurs is called the:
   - a. Shear plane
   - b. Shear zone
   - c. Rupture area
   - d. Plastic flow

6. In a turning operation, the vertical force is in the direction of the cutting speed and is referred to the:
   a. Feed force
   b. Cutting force
   c. Turning force
   d. Cutting feed

7. The relationship between the velocity of the cutting tool and the work piece is called the:
   a. Velocity ration
   b. Tool velocity
   c. Cutting speed
   d. Cutting feed

8. Calculate the RPM for a 1/2" diameter drill in tool steel (CS=60 SFM) with a high-speed steel drill.

____

____

____

9. List and explain two ways of specifying feed rate.

____

____

____

10. Define machinability.

____

____

____

11. List and define the three basic types of chip formations.

____

____

____

12. What is *rake angle*?

____

____

____

13. What is the purpose of a nose radius?

____

____

____

14. What is the purpose of end relief?

15. Name 3 materials that cutting tools are made of and characterize each.

16. In an ANSI insert designation, what information does the first digit identify?

17. List 4 functions of a cutting fluid.

18. List 3 types of cutting fluids.

19. List and explain 3 application methods for cutting fluids.

20. Determine the appropriate tool geometry for a carbide insert taking 1/4" depth of cut at .020 IPR feed in tool steel.

TOOL & DIE and EDM SERIES

MASTER Technical Module No. TLD-F2

Subject: **Tool & Die and EDM** **Time: 10 Hrs.**

Duty: **Demonstrate Knowledge of Manufacturing Processes**
Task: Operate Metal Saws

Objective(s):

Upon completion of this unit the student will be able to:

a. Define bandsaw, horizontal and vertical;
b. Discuss bandsaw safety;
c. Explain machine components and accessories of bandsaws;
d. Discuss application of the various tooth forms, pitch sets, and gages of bandsaw blades;
e. Weld and maintain bandsaw blade;
f. Calculate proper length of bandsaw blade;
g. Use recommended cutting speed and feed rate for specific materials and tooling;
h. Define circular type metal saws, abrasive cutoff and cold circular;
i. Discuss circular saw safety;
j. Explain tooling (blades and wheels) on circular saws; and,
k. Setup and operate bandsaw and circular saw.

Instructional Materials:

MASTER Handout (TLD-F2-HO)
MASTER Laboratory Aid (TLD-F2-LA)
MASTER Self-Assessment

References:

Technology of Machine Tools, Steve Krar and Albert Check, Glencoe Publishing, Latest Edition

Machine Tool and Manufacturing Technology, Krar, Rapisarda, and Check, Delmar Publishers, Latest Edition

NTMA Machinist Training Program Module(s), National Tooling and Machining Association, 9399 Livingston Road, Fort Washington, MD 20744, Latest Edition

Instructor's Guide, Technology of Machine Tools, Amand, Krar, and Oswald, McGraw-Hill Publishers, Latest Edition

Workbook for Technology of Machine Tools, Amand, Krar, and Oswald, McGraw-Hill Publishers, Latest Edition
Modern Metalworking, John R. Walker , Goodheart-Willcox, Latest Edition
Metalwork; Technology and Practice, Victor E. Repp, Glencoe Publishing, Latest Edition
Machining Fundamentals, John R. Walker , Goodheart-Willcox, Latest Edition
Fundamentals of Machine Tool Technology and Manufacturing Processes, C. Thomas Olivo, Delmar Publishing, Latest Edition
Advanced Machine Tool Technology and Manufacturing Processes, C. Thomas Olivo, Delmar, Latest Edition
Application of Metal Cutting Theory, Fryderyk E. Gorczyca, Industrial Press, Latest Edition
Abrasive Methods Engineering Volume II, Francis T. Farago, Industrial Press, Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:

TLD-A1 through TLD-A6	"Practice Safety"
TLD-B1 through TLD-B5	"Apply Mathematical Concepts"
TLD-C1	"Interpret and Understand Basic Layout/Types of Drawings"
TLD-C2	"Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances"
TLD-C3	"Use and Apply Geometric Dimensioning and Tolerancing (GD&T)"
TLD-C4	"Demonstrate Traditional Mechanical Drafting and Sketching Techniques"
TLD-D1 through TLD-D3	"Demonstrate Knowledge of Manufacturing Materials"
TLD-E1 through TLD-E6	"Measure/Inspect"
TLD-F1	"Discuss Metal Cutting and Metal Cutting Tools"

Introduction:

A necessary component of all machine shops is some form of metal cutting saw. The saw is the most efficient and economical way to remove unwanted material from the stock piece. The tool and die maker must be familiar with saw operations and techniques to perform tasks such as cutoff of piece blank from stock material or rough cutting a profile. Without the knowledge of metal saws, machinist would find many tasks almost impossible and much more expensive to perform.

Presentation Outline:

- I. Define Bandsaw and Identify Types
  - A. Horizontal
  - B. Vertical
- II. Discuss Bandsaw Safety
- III. Explain Machine Components and Accessories of Bandsaws
  - A. Horizontal
    - 1. Saw frame
    - 2. Vise
    - 3. Stop gage
    - 4. Pulleys
    - 5. Blade tension handle
    - 6. Roller guide brackets
    - 7. Saw blade
    - 8. Power stock feed
    - 9. Coolant
  - B. Vertical (contour)
    - 1. Column
    - 2. Head
    - 3. Base
    - 4. Pulleys
    - 5. Table
    - 6. Saw guides
    - 7. Table tilt handwheel
    - 8. Butt welder
    - 9. Blade grinder
    - 10. Coolant
    - 11. Power feed
- IV. Discuss Bandsaw Blades
  - A. Tooth forms
    - 1. Precision or regular tooth
    - 2. Claw or hook tooth
    - 3. Buttress or skip tooth
  - B. Pitch
  - C. Set
    - 1. Raker
    - 2. Wave
    - 3. Straight
  - D. Width
  - E. Gage
  - F. Material
  - G. Specialty blades
- V. Explain How to Calculate Proper Length of Bandsaw Blade

VI. Explain How to Weld and Maintain Bandsaw Blade

VII. Explain How to Determine Cutting Speed and Feed Rate for Specific Materials and Tooling Using Charts And/or Selector Dial

VIII. Define Circular Type Metal Saws and Identify Types and Uses
    A. Cold circular
    B. Abrasive cutoff

IX. Discuss Circular Metal Saw Safety

X. Discuss Tooling (Blades and Wheels) on Circular Saws
    A. Cold circular blades (reiterate tooth forms, pitch, set, gage, and material)
    B. Abrasive cut-off wheels
        1. Grade
        2. Material

XI. Setup and Operate Bandsaw and Circular Saw
    A. Safety
    B. Horizontal
    C. Vertical
    D. Cold circular
    E. Abrasive cutoff

Practical Application:

Students should be given a demonstration of the operation of each of the types of metal saws. They should then complete several sawing projects utilizing each type of saw.

Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this lesson as well as demonstrate the operation of metal saws.

Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-F3) dealing with operation of drilling presses and tooling.

TLD-F2-HO
Operate Metal Saws
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Define bandsaw, horizontal and vertical;
b. Discuss bandsaw safety;
c. Explain machine components and accessories of bandsaws;
d. Discuss application of the various tooth forms, pitch sets, and gages of bandsaw blades;
e. Weld and maintain bandsaw blade;
f. Calculate proper length of bandsaw blade;
g. Use recommended cutting speed and feed rate for specific materials and tooling;
h. Define circular type metal saws, abrasive cutoff and cold circular;
i. Discuss circular saw safety;
j. Explain tooling (blades and wheels) on circular saws; and,
k. Setup and operate bandsaw and circular saw.

Module Outline:

I. Define Bandsaw and Identify Types
    A. Horizontal
    B. Vertical
II. Discuss Bandsaw Safety
III. Explain Machine Components and Accessories of Bandsaws
    A. Horizontal
        1. Saw frame
        2. Vise
        3. Stop gage
        4. Pulleys
        5. Blade tension handle
        6. Roller guide brackets
        7. Saw blade
        8. Power stock feed
        9. Coolant
    B. Vertical (contour)
        1. Column
        2. Head
        3. Base
        4. Pulleys
        5. Table

    - 6. Saw guides
    - 7. Table tilt handwheel
    - 8. Butt welder
    - 9. Blade grinder
    - 10. Coolant
    - 11. Power feed
- IV. Discuss Bandsaw Blades
  - A. Tooth forms
    - 1. Precision or regular tooth
    - 2. Claw or hook tooth
    - 3. Buttress or skip tooth
  - B. Pitch
  - C. Set
    - 1. Raker
    - 2. Wave
    - 3. Straight
  - D. Width
  - E. Gage
  - F. Material
  - G. Specialty blades
- V. Explain How to Calculate Proper Length of Bandsaw Blade
- VI. Explain How to Weld and Maintain Bandsaw Blade
- VII. Explain How to Determine Cutting Speed and Feed Rate for Specific Materials and Tooling Using Charts And/or Selector Dial
- VIII. Define Circular Type Metal Saws and Identify Types and Uses
  - A. Cold circular
  - B. Abrasive cutoff
- IX. Discuss Circular Metal Saw Safety
- X. Discuss Tooling (Blades and Wheels) on Circular Saws
  - A. Cold circular blades (reiterate tooth forms, pitch, set, gage, and material)
  - B. Abrasive cut-off wheels
    - 1. Grade
    - 2. Material
- XI. Setup and Operate Bandsaw and Circular Saw
  - A. Safety
  - B. Horizontal
  - C. Vertical
  - D. Cold circular
  - E. Abrasive cutoff

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

Name ______________________________ Date ________________

TLD-F2
Operate Metal Saws
Self-Assessment

1. List 5 components or accessories of a horizontal bandsaw and give function of each.

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2. List 5 components or accessories of a vertical bandsaw and give function of each.

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3. List the types of tooth forms for bandsaw blades and give application of each.

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4. Define pitch.

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5. List and distinguish between the different types of set patterns.

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6. What is a band file?

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7. Calculate the length of saw band required for a contour bandsaw with two 30" diameter pulleys with a center-to-center distance of 50".

8. List the primary steps to weld and grind a saw blade.

9. What method is used to determine the proper cutting speed for a bandsaw operation?

10. What is a contour bandsaw

11. Define a cold circular saw.

12. Define an abrasive cut-off machine

13. What type metal would a aluminum oxide wheel be used for?

14. Discuss the relationship between the diameter and the thickness of the wheel.

15. Discuss saw safety.

TOOL & DIE and EDM SERIES
MASTER Technical Module No. TLD-F3

Subject: Tool & Die and EDM **Time: 15 Hrs.**

Duty: Demonstrate Knowledge of Manufacturing Processes
Task: Operate Drill Presses and Tooling

Objective(s):

Upon completion of this unit the student will be able to:

a. Identify types of drilling machines;
b. Discuss drilling machine safety;
c. Explain machine components and accessories of drilling machines;
d. Describe and give function of various types of tooling used on drilling machines;
e. Explain processes performed on drilling machines;
f. Calculate speeds and feeds based on materials and tooling; and,
g. Set-up and operate drilling machines.

Instructional Materials:

MASTER Handout (TLD-F3-HO)
MASTER Laboratory Aid (TLD-F3-LA)
MASTER Self-Assessment

References:

Technology of Machine Tools, Steve Krar and Albert Check, Glencoe Publishing, Latest Edition
Machine Tool and Manufacturing Technology, Krar, Rapisarda, and Check, Delmar Publishers, Latest Edition
NTMA Machinist Training Program Module(s), National Tooling and Machining Association, 9399 Livingston Road, Fort Washington, MD 20744, Latest Edition
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Workbook for Technology of Machine Tools, Amand, Krar, and Oswald, McGraw-Hill Publishers, Latest Edition
Modern Metalworking, John R. Walker , Goodheart-Willcox, Latest Edition
Metalwork; Technology and Practice, Victor E. Repp, Glencoe Publishing, Latest Edition

Machining Fundamentals, John R. Walker , Goodheart-Willcox, Latest Edition
Fundamentals of Machine Tool Technology and Manufacturing Processes, C. Thomas Olivo, Delmar Publishing, Latest Edition
Advanced Machine Tool Technology and Manufacturing Processes, C. Thomas Olivo, Delmar, Latest Edition
Application of Metal Cutting Theory, Fryderyk E. Gorczyca, Industrial Press, Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:

TLD-A1 through TLD-A6	"Practice Safety"
TLD-B1 through TLD-B5	"Apply Mathematical Concepts"
TLD-C1	"Interpret and Understand Basic Layout/Types of Drawings"
TLD-C2	"Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances"
TLD-C3	"Use and Apply Geometric Dimensioning and Tolerancing (GD&T)"
TLD-C4	"Demonstrate Traditional Mechanical Drafting and Sketching Techniques"
TLD-D1 through TLD-D3	"Demonstrate Knowledge of Manufacturing Materials"
TLD-E1 through TLD-E6	"Measure/Inspect"
TLD-F1	"Discuss Metal Cutting an Metal Cutting Tools"
TLD-F2	"Operate Metal Saws"

Introduction:

One of the most common and useful machines in a tool and die shop is the drill press. Although modern drilling machines come in several types, sizes, and complexity, they share a common purpose: to produce holes. It is imperative that tool and die makers become proficient at the operation of these machines since a large part of his/her job will be hole production in tools and dies. By studying drilling machines, tooling, setups, and drilling processes, students can learn the proper methods and procedures to produce accurate holes at precise locations.

Presentation Outline:

I. Identify Types of Drilling Machines
    A. Bench-type sensitive drill press
    B. Upright drilling machine
    C. Radial drilling machine

- D. Numerical controlled drilling machine
- II. Discuss Drill Safety
- III. Explain Machine Components and Accessories of Drilling Machines
  - A. Major components
    - 1. Base
    - 2. Column
    - 3. Table
    - 4. Drilling head
    - 5. Radial Arm
  - B. Accessories
    - 1. Tool-holding devices
      - a. Chucks
      - b. Sleeves and sockets
    - 2. Work-holding devices
      - a. Vise (drill, angle, contour)
      - b. V-blocks
      - c. Clamps, straps, and step blocks
      - d. Angle plate
      - e. Drill jig
- IV. Describe and Give Function and Maintenance of Various Types of Tooling Used on Drilling Machines
  - A. Drills
    - 1. Twist
      - a. Geometry and parts
      - b. Sizes
      - c. Grinding
    - 2. Center
    - 3. Core
    - 4. Spade
    - 5. Step
  - B. Reamers
    - 1. Rose-type
    - 2. Shell-type
    - 3. Expansion-type
    - 4. Adjustable-type
  - C. Counterbore
  - D. Countersink
  - E. Tap
- V. Explain Processes Performed on Drilling Machines
  - A. Layout for drilling operations
  - B. Drilling
  - C. Reaming
  - D. Counterboring
  - E. Spotfacing
  - F. Countersinking

    G. Tapping

VI. Calculate Speeds and Feeds Based on Materials and Tooling
    A. Drilling
    B. Reaming
    C. Counterboring/spotfacing
    D. Countersinking
    E. Tapping

VII. Set-Up and Operate Drilling Machines

Practical Application:

Students should be given demonstration of drill press operation performing each of the above processes. They should then be given projects to perform each process on the drilling machine.

Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-F4) dealing with operating engine and turret lathes and tooling.

TLD-F3-HO
Operate Drill Presses and Tooling
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Identify types of drilling machines;
b. Discuss drilling machine safety;
c. Explain machine components and accessories of drilling machines;
d. Describe and give function of various types of tooling used on drilling machines;
e. Explain processes performed on drilling machines;
f. Calculate speeds and feeds based on materials and tooling; and,
g. Set-up and operate drilling machines.

Module Outline:

I. Identify Types of Drilling Machines
    A. Bench-type sensitive drill press
    B. Upright drilling machine
    C. Radial drilling machine
    D. Numerical controlled drilling machine
II. Discuss Drill Safety
III. Explain Machine Components and Accessories of Drilling Machines
    A. Major components
        1. Base
        2. Column
        3. Table
        4. Drilling head
        5. Radial Arm
    B. Accessories
        1. Tool-holding devices
            a. Chucks
            b. Sleeves and sockets
        2. Work-holding devices
            a. Vise (drill, angle, contour)
            b. V-blocks
            c. Clamps, straps, and step blocks
            d. Angle plate
            e. Drill jig
IV. Describe and Give Function and Maintenance of Various Types of Tooling Used on Drilling Machines
    A. Drills

        1. Twist
            a. Geometry and parts
            b. Sizes
            c. Grinding
        2. Center
        3. Core
        4. Spade
        5. Step
    B. Reamers
        1. Rose-type
        2. Shell-type
        3. Expansion-type
        4. Adjustable-type
    C. Counterbore
    D. Countersink
    E. Tap

V. Explain Processes Performed on Drilling Machines
    A. Layout for drilling operations
    B. Drilling
    C. Reaming
    D. Counterboring
    E. Spotfacing
    F. Countersinking
    G. Tapping

VI. Calculate Speeds and Feeds Based on Materials and Tooling
    A. Drilling
    B. Reaming
    C. Counterboring/spotfacing
    D. Countersinking
    E. Tapping

VII. Set-Up and Operate Drilling Machines

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and,
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

Name______________________________ **Date**_______________

TLD-F3
Operate Drill Presses and Tooling
Self-Assessment

1. List and discuss three types of drilling machines.

2. List five safety precautions for a drill press.

3. Describe and state the purpose of each component of a drilling machine.

4. Name the two types of tool-holding devices used on drilling machines and describe each.

5. Name three ways that work may be held for drilling operations.

6. Name four types of drills and discuss the application of each.

7. List seven of the most important hints for drilling.

8. Name and describe three types of reamers.

9. Define counterbore.

10. How is a tap used on a drilling machine?

11. Why is it good practice to start each hole with a center drill?

12. List the procedure for laying out a hole before drilling.

13. List the procedure for drilling large holes.

14. What is the general rule for the amount of material left in a hole for machine reaming?

15. List seven of the most important reaming hints.

16. Why should holes that are to be tapped be countersunk?

17. Describe the procedure for tapping a hole by hand in a drill press.

18. Name three methods of transferring the location of holes from one part to another.

19. What are transfer punches and how are they used?

20. Calculate the RPM and feed rate for a 3/8" diameter drill in tool steel.

TLD-F4

TOOL & DIE and EDM SERIES

MASTER Technical Module No. TLD-F4

Subject: **Tool & Die and EDM** **Tune: 30 Hrs.**

Duty: **Demonstrate Knowledge of Manufacturing Processes**
Task: Operate Engine and Turret Lathes and Tooling

Objective(s):

Upon completion of this unit the student will be able to:

a. Define lathes, engine and turret;
b. Discuss lathe safety;
c. Explain machine components and accessories of lathes;
d. Describe and give function and maintenance of various types of tooling used on lathes;
e. Explain turning processes, inside and outside;
f. Calculate speeds and feeds based on materials, tooling and setup; and,
g. Set-up and operate engine and turret lathes.

Instructional Materials:

MASTER Handout (TLD-F4-HO)
MASTER Laboratory Aid (TLD-F4-LA)
MASTER Self-Assessment

References:

Technology of Machine Tools, Steve Krar and Albert Check, Glencoe Publishing, Latest Edition
Machine Tool and Manufacturing Technology, Krar, Rapisarda, and Check, Delmar Publishers, Latest Edition
NTMA Machinist Training Program Module(s), National Tooling and Machining Association, 9399 Livingston Road, Fort Washington, MD 20744, Latest Edition
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Workbook for Technology of Machine Tools, Amand, Krar, and Oswald, McGraw-Hill Publishers, Latest Edition
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Metalwork; Technology and Practice, Victor E. Repp, Glencoe Publishing, Latest Edition

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Fundamentals of Machine Tool Technology and Manufacturing Processes, C. Thomas Olivo, Delmar Publishing, Latest Edition
Advanced Machine Tool Technology and Manufacturing Processes, C. Thomas Olivo, Delmar, Latest Edition
Application of Metal Cutting Theory, Fryderyk E. Gorczyca, Industrial Press, Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:

TLD-A1 through TLD-A6 "Practice Safety"
TLD-B1 through TLD-B5 "Apply Mathematical Concepts"
TLD-C1 "Interpret and Understand Basic Layout/Types of Drawings"
TLD-C2 "Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances"
TLD-C3 "Use and Apply Geometric Dimensioning and Tolerancing (GD&T)"
TLD-C4 "Demonstrate Traditional Mechanical Drafting and Sketching Techniques"
TLD-D1 through TLD-D3 "Demonstrate Knowledge of Manufacturing Materials"
TLD-E1 through TLD-E6 "Measure/Inspect"
TLD-F1 "Discuss Metal Cutting an Metal Cutting Tools"
TLD-F2 "Operate Metal Saws"
TLD-F3 "Operate Drill Presses and Tooling"

Introduction:

An essential part of any machine shop is the lathe. It is one of the most versatile machine tools used in industry. Modern lathes incorporate the same basic principle of the potter's wheel forming clay into a cylindrical shape. Because many parts can only be produced with a lathe, it is imperative that tool and die makers become proficient at its operation and processes.

Presentation Outline:

I. Define Lathes and Identify Types
    A. Engine
    B. Turret
    C. Computer Numerical Control (CNC)
II. Discuss Lathe Safety
III. Explain Machine Components and Accessories of Lathes

- A. Major components
  - 1. Bed
  - 2. Headstock
  - 3. Gearbox
  - 4. Carriage
    - a. Saddle
    - b. Cross-slide
    - c. Compound rest
  - 5. Tailstock
- B. Accessories
  - 1. Centers
  - 2. Chucks
    - a. Three-jaw universal
    - b. Four-jaw independent
    - c. Collet-type
    - d. Magnetic
  - 3. Faceplate
  - 4. Steadyrest
  - 5. Follower rest
  - 6. Lathe dogs
  - 7. Toolposts
  - 8. Tool holders

IV. Describe and Give Function and Maintenance of Various Types of Tooling Used on Lathes

- A. Types
  - 1. O.D. turning tools
  - 2. I.D. turning tools
  - 3. Face turning tools
  - 4. Threading tools
  - 5. Grooving tools
  - 6. Knurling tools
  - 7. Form tools
- B. Maintenance and grinding

V. Explain Turning Processes

- A. Inside operations
  - 1. Drilling, tapping, reaming
  - 2. Boring
  - 3. Threading
  - 4. Chamfering
  - 5. Grooving
  - 6. Taper boring
- B. Outside operations
  - 1. Turning
    - a. Chuck turning
    - b. Between centers

        - c. Form turning
        - d. Taper turning
    - 2. Facing
    - 3. Threading
    - 4. Grooving
    - 5. Knurling
    - 6. Chamfering
    - 7. Cut-off
  - C. Explain depth of cut
- VI. Calculate Speeds and Feeds Based on Materials, Tooling, and Setup
- VII. Set-Up and Operate Engine and Turret Lathes

Practical Application:

Student's first project should be to grind tool bit for turning and threading. Students should then be given several lathe projects involving the processes identified above.

Evaluation and/or Verification:

Students should successfully complete the Practical Application above and the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-F5) dealing with operating vertical and horizontal mills and tooling.

TLD-F4-HO
Operate Engine and Turret Lathes and Tooling
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Define lathes, engine and turret;
b. Discuss lathe safety;
c. Explain machine components and accessories of lathes;
d. Describe and give function and maintenance of various types of tooling used on lathes;
e. Explain turning processes, inside and outside;
f. Calculate speeds and feeds based on materials, tooling and setup; and,
g. Set-up and operate engine and turret lathes.

Module Outline:

I. Define Lathes and Identify Types
    A. Engine
    B. Turret
    C. Computer Numerical Control (CNC)
II. Discuss Lathe Safety
III. Explain Machine Components and Accessories of Lathes
    A. Major components
        1. Bed
        2. Headstock
        3. Gearbox
        4. Carriage
            a. Saddle
            b. Cross-slide
            c. Compound rest
        5. Tailstock
    B. Accessories
        1. Centers
        2. Chucks
            a. Three-jaw universal
            b. Four-jaw independent
            c. Collet-type
            d. Magnetic
        3. Faceplate
        4. Steadyrest
        5. Follower rest
        6. Lathe dogs

        7. Toolposts
        8. Tool holders
- IV. Describe and Give Function and Maintenance of Various Types of Tooling Used on Lathes
    - A. Types
        - 1. O.D. turning tools
        - 2. I.D. turning tools
        - 3. Face turning tools
        - 4. Threading tools
        - 5. Grooving tools
        - 6. Knurling tools
        - 7. Form tools
    - B. Maintenance and grinding
- V. Explain Turning Processes
    - A. Inside operations
        - 1. Drilling, tapping, reaming
        - 2. Boring
        - 3. Threading
        - 4. Chamfering
        - 5. Grooving
        - 6. Taper boring
    - B. Outside operations
        - 1. Turning
            - a. Chuck turning
            - b. Between centers
            - c. Form turning
            - d. Taper turning
        - 2. Facing
        - 3. Threading
        - 4. Grooving
        - 5. Knurling
        - 6. Chamfering
        - 7. Cut-off
    - C. Explain depth of cut
- VI. Calculate Speeds and Feeds Based on Materials, Tooling, and Setup
- VII. Set-Up and Operate Engine and Turret Lathes

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and,
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

Name__________________________ Date_______________

TLD-F4
Operate Engine and Turret Lathes and Tooling
Self-Assessment

1. Identify types of lathes and discuss differences.

2. List five safety rules or precautions for lathe operation.

3. Name the five main units of a lathe.

4. What is the purpose of the cross-slide?

5. What is the purpose of the compound rest?

6. Name the three types of lathe centers and state the purpose of each.

7. Distinguish between a steadyrest and a follower rest.

8. Define and state the purpose of lathe dogs.

9. Name and state the purpose of four types of toolposts.

10. Describe three types of standard toolholders and state the purpose of each.

11. Make a sketch of a single-point cutting tool and label the face, cutting edge, nose, point, flank, and shank.

12. Describe the process for grinding a general-purpose toolbit.

13. Define a form tool and give an example of one.

14. Describe the process of using a twist drill bit in the tailstock to drill holes.

15. Describe knurling tools.

16. Describe threading tools, I.D. and O.D.

17. Explain how to machine an O.D. journal.

18. Describe a boring bar.

19. Explain a grooving process.

20. Explain the difference in techniques between turning material held in a chuck and material held between centers.

21. Calculate the TPF and tailstock offset for a taper with the following dimensions: *D*=1.625", *d*=1.425", *TL*=3", *OL*=10".

22. Calculate the RPM to rough-turn a 3.75" dia. piece of machine steel using a high-speed steel toolbit.

23. Define lathe feed.

24. What would the depth of the finishing cut be for a 2-1/2" dia. workpiece to be machined to 2.375" dia.?

25. Explain the knurling procedure, including the proper cutting speed and feed.

26. List the steps required to cut a 1-1/4 - 7 UNC thread on a 1-1/2" dia. shaft.

27. Explain how to true work in a four-jaw independent chuck.

28. List the steps to cut-off work in a chuck.

29. Explain the steps to bore a hole using the cross-slide and compound rest.

30. Explain the three-wire method of measuring 60° threads. Include the calculations required.

TOOL & DIE and EDM SERIES

MASTER Technical Module No. TLD-F5

Subject: **Tool & Die and EDM** **Time: 30 Hrs.**

Duty: **Demonstrate Knowledge of Manufacturing Processes**
Task: Operate Vertical and Horizontal Mills and Tooling

Objective(s):

Upon completion of this unit the student will be able to:
a. Define milling machines, horizontal and vertical;
b. Discuss mill safety;
c. Explain machine components and accessories of milling machines;
d. Describe and give function of different types of tooling used on milling machines;
e. Explain milling processes;
f. Explain boring processes on milling machine;
g. Explain precision set-ups on the milling machine;
h. Calculate speeds, feeds, and depth of cut based on materials, tooling and setup; and,
i. Set-up and operate horizontal and vertical milling machine for milling and boring operations.

Instructional Materials:

MASTER Handout (TLD-F5-HO)
MASTER Laboratory Aid (TLD-F5-LA)
MASTER Self-Assessment

References:

Technology of Machine Tools, Steve Krar and Albert Check, Glencoe Publishing, Latest Edition
Machine Tool and Manufacturing Technology, Krar, Rapisarda, and Check, Delmar Publishers, Latest Edition
NTMA Machinist Training Program Module(s), National Tooling and Machining Association, 9399 Livingston Road, Fort Washington, MD 20744, Latest Edition
Instructor's Guide, Technology of Machine Tools, Amand, Krar, and Oswald, McGraw-Hill Publishers, Latest Edition
Workbook for Technology of Machine Tools, Amand, Krar, and Oswald, McGraw-Hill Publishers, Latest Edition

Modern Metalworking, John R. Walker , Goodheart-Willcox, Latest Edition

Metalwork; Technology and Practice, Victor E. Repp, Glencoe Publishing, Latest Edition

Machining Fundamentals, John R. Walker , Goodheart-Willcox, Latest Edition

Fundamentals of Machine Tool Technology and Manufacturing Processes, C. Thomas Olivo, Delmar Publishing, Latest Edition

Advanced Machine Tool Technology and Manufacturing Processes, C. Thomas Olivo, Delmar, Latest Edition

Application of Metal Cutting Theory, Fryderyk E. Gorczyca, Industrial Press, Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:

TLD-A1 through TLD-A6	"Practice Safety"
TLD-B1 through TLD-B5	"Apply Mathematical Concepts"
TLD-C1	"Interpret and Understand Basic Layout/Types of Drawings"
TLD-C2	"Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances"
TLD-C3	"Use and Apply Geometric Dimensioning and Tolerancing (GD&T)"
TLD-C4	"Demonstrate Traditional Mechanical Drafting and Sketching Techniques"
TLD-D1 through TLD-D3	"Demonstrate Knowledge of Manufacturing Materials"
TLD-E1 through TLD-E6	"Measure/Inspect"
TLD-F1	"Discuss Metal Cutting an Metal Cutting Tools"
TLD-F2	"Operate Metal Saws"
TLD-F3	"Operate Drill Presses and Tooling"
TLD-F4	"Operate Engine and Turret Lathes and Tooling"

Introduction:

The milling machine is a versatile machine tool which can accurately utilize at least three axes to machine an unlimited variety of shapes. It can also handle many tasks normally performed by other machine tools such as drilling, reaming, thread cutting, boring, facing, and more. Because of its flexibility and usefulness, machinist and tool makers will spend countless hours operating a milling machine. Similarly, machine shop and tool and die students should be given instruction and experience in milling operations and processes.

Presentation Outline:

I. Define Milling Machines
   A. Horizontal
      1. Manufacturing type
      2. Knee-and-column type
   B. Vertical
      1. Standard
      2. Ram type
   C. CNC Machining Centers
II. Discuss Mill Safety
III. Explain Machine Components and Accessories of Milling Machines
   A. Major components
      1. Base
      2. Column
      3. Overarm
      4. Table
      5. Saddle
      6. Knee
   B. Accessories
      1. Fixtures
      2. Vises
      3. Parallel bars
      4. Arbors, collets, and adapters
      5. Milling attachment
      6. Slotting attachment
      7. Indexing or dividing head
      8. Rotary table
      9. Backlash eliminator
IV. Describe and Give Function of Different Types of Tooling Used on Milling Machines
   A. Arbor type cutters
      1. Plain
      2. Side-milling
      3. Face-milling
      4. Angular
      5. Formed
   B. End mills
      1. Standard
      2. Ball
      3. Bull
      4. Formed
      5. Shell
   C. Specialty cutters

        1. T-slot
        2. Dovetail
        3. Woodruff keyseat
        4. Flycutter
    D. Tooling materials
        1. High speed steel
        2. Carbide brazed
        3. Carbide inserted

V. Explain Milling Processes
    A. Face milling
    B. Side milling
    C. Straddle milling
    D. Slot or keyseat milling
    E. Gang milling
    F. Sawing or slitting
    G. Specialty milling (T-slot, dovetail, woodruff keyseat, etc.)

VI. Explain Boring Processes on Milling Machine

VII. Explain Precision Set-Ups on the Milling Machine
    A. Using the dial indicator
    B. Digital readout devices
    C. Aligning the head and table
    D. Aligning the vise or fixture
    E. Finding edge, center, or face locations

VIII. Calculate Speeds, Feeds, and Depth of Cut Based on Materials, Tooling and Setup

IX. Set-Up and Operate Horizontal and Vertical Milling Machine for Milling and Boring Operations

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Practical Application:

Students should be given assigned projects involving the above setups and processes.

Evaluation and/or Verification:

Students should successfully complete the Practical Application above and the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-F6) dealing with operating precision grinders.

TLD-F5-HO
Operate Vertical and Horizontal Mills and Tooling
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Define milling machines, horizontal and vertical;
b. Discuss mill safety;
c. Explain machine components and accessories of milling machines;
d. Describe and give function of different types of tooling used on milling machines;
e. Explain milling processes;
f. Explain boring processes on milling machine;
g. Explain precision set-ups on the milling machine;
h. Calculate speeds, feeds, and depth of cut based on materials, tooling and setup; and,
i. Set-up and operate horizontal and vertical milling machine for milling and boring operations.

Module Outline:

I. Define Milling Machines
    A. Horizontal
        1. Manufacturing type
        2. Knee-and-column type
    B. Vertical
        1. Standard
        2. Ram type
    C. CNC Machining Centers
II. Discuss Mill Safety
III. Explain Machine Components and Accessories of Milling Machines
    A. Major components
        1. Base
        2. Column
        3. Overarm
        4. Table
        5. Saddle
        6. Knee
    B. Accessories
        1. Fixtures
        2. Vises
        3. Parallel bars
        4. Arbors, collets, and adapters

    5. Milling attachment
    6. Slotting attachment
    7. Indexing or dividing head
    8. Rotary table
    9. Backlash eliminator

IV. Describe and Give Function of Different Types of Tooling Used on Milling Machines
  A. Arbor type cutters
    1. Plain
    2. Side-milling
    3. Face-milling
    4. Angular
    5. Formed
  B. End mills
    1. Standard
    2. Ball
    3. Bull
    4. Formed
    5. Shell
  C. Specialty cutters
    1. T-slot
    2. Dovetail
    3. Woodruff keyseat
    4. Flycutter
  D. Tooling materials
    1. High speed steel
    2. Carbide brazed
    3. Carbide inserted

V. Explain Milling Processes
  A. Face milling
  B. Side milling
  C. Straddle milling
  D. Slot or keyseat milling
  E. Gang milling
  F. Sawing or slitting
  G. Specialty milling (T-slot, dovetail, woodruff keyseat, etc.)

VI. Explain Boring Processes on Milling Machine

VII. Explain Precision Set-Ups on the Milling Machine
  A. Using the dial indicator
  B. Digital readout devices
  C. Aligning the head and table
  D. Aligning the vise or fixture
  E. Finding edge, center, or face locations

VIII. Calculate Speeds, Feeds, and Depth of Cut Based on Materials, Tooling and Setup

IX. Set-Up and Operate Horizontal and Vertical Milling Machine for Milling and Boring Operations

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and,
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

Name________________________ Date______________

TLD-F5
Operate Vertical and Horizontal Mills and Tooling
Self-Assessment

1. List types of horizontal milling machines and distinguish between each.

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2. List types of vertical milling machines and distinguish between each.

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3. List five safety rules or precautions for milling machine operation.

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4. Name the six main units of a milling machine.

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5. What is the purpose of a fixture?

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6. Explain how parallel bars can be used in conjunction with a vise to machine parallel surfaces.

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7. Name three methods of holding cutters on a milling machine.

8. Name three materials used in milling cutters.

9. List three types of arbor type cutters and discuss differences and applications of each.

10. List three types of end mills and discuss each.

11. Discuss what is meant by "center-cutting" end mills?

12. Explain face milling.

13. Explain straddle milling.

14. Explain gang milling.

15. Distinguish between climb and conventional milling.

16. Explain the purpose of the backlash eliminator.

17. Explain a boring operation on a milling machine.

18. Explain how to use a dial indicator to align the head and table of a milling machine.

19. Explain how to "indicate in" or align a fixture or vise with the milling machine.

20. Explain how to set the cutter to the work surface using a long, thin piece of paper.

21. Determine the cutter speed, feed, and depth of cut for a 1/2" dia. 2-flute standard end mill cutting low-carbon steel held in a vise.

22. List the steps to set-up a die block and bore a close-tolerance hole to a precise location.

23. List the steps to set-up and machine a block square and parallel and to a specific size.

24. List the steps to accurately cut a 1/4" X 3" keyseat 1" from the end of a 2" dia. shaft. Include the calculations required and the measurement techniques.

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25. Explain how to use a rotary table to mill a circular slot or surface.

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TLD-F6

TOOL & DIE and EDM SERIES
MASTER Technical Module No. TLD-F6

Subject: **Tool & Die and EDM** **Time: 25 Hrs.**

Duty: **Demonstrate Knowledge of Manufacturing Processes**
Task: Operate Precision Grinders

Objective(s):

Upon completion of this module the student will be able to:
a. Define types of precision grinders;
b. Discuss grinding safety;
c. Identify major components and accessories of grinding machines;
d. Identify types, nomenclature, and uses of grinding wheels;
e. Discuss care and maintenance of grinding wheels;
f. Identify the factors involved in electing grinding wheel specifications;
g. Explain grinding processes; and,
h. Setup and operate precision grinding machines.

Instructional Materials:

MASTER Handout (TLD-F6-HO)
MASTER Laboratory Aid (TLD-F6-LA)
MASTER Self-Assessment

References:

Technology of Machine Tools, Steve Krar and Albert Check, Glencoe Publishing, Latest Edition
Machine Tool and Manufacturing Technology, Krar, Rapisarda, and Check, Delmar Publishers, Latest Edition
NTMA Machinist Training Program Module(s), National Tooling and Machining Association, 9399 Livingston Road, Fort Washington, MD 20744, Latest Edition
Instructor's Guide, Technology of Machine Tools, Amand, Krar, and Oswald, McGraw-Hill Publishers, Latest Edition
Workbook for Technology of Machine Tools, Amand, Krar, and Oswald, McGraw-Hill Publishers, Latest Edition
Modern Metalworking, John R. Walker , Goodheart-Willcox, Latest Edition
Metalwork; Technology and Practice, Victor E. Repp, Glencoe Publishing, Latest Edition

Machining Fundamentals, John R. Walker , Goodheart-Willcox, Latest Edition

Fundamentals of Machine Tool Technology and Manufacturing Processes, C. Thomas Olivo, Delmar Publishing, Latest Edition

Advanced Machine Tool Technology and Manufacturing Processes, C. Thomas Olivo, Delmar, Latest Edition

Application of Metal Cutting Theory, Fryderyk E. Gorczyca, Industrial Press, Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:

TLD-A1 through TLD-A6	"Practice Safety"
TLD-B1 through TLD-B5	"Apply Mathematical Concepts"
TLD-C1	"Interpret and Understand Basic Layout/Types of Drawings"
TLD-C2	"Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances"
TLD-C3	"Use and Apply Geometric Dimensioning and Tolerancing (GD&T)"
TLD-C4	"Demonstrate Traditional Mechanical Drafting and Sketching Techniques"
TLD-D1 through TLD-D3	"Demonstrate Knowledge of Manufacturing Materials"
TLD-E1 through TLD-E6	"Measure/Inspect"
TLD-F1	"Discuss Metal Cutting an Metal Cutting Tools"
TLD-F2	"Operate Metal Saws"
TLD-F3	"Operate Drill Presses and Tooling"
TLD-F4	"Operate Engine and Turret Lathes and Tooling"
TLD-F5	"Operate Vertical and Horizontal Mills and Tooling"

Introduction:

One of the most important processes to a tool maker is precision grinding. Initially used only for hardened parts, grinding was once considered impractical and more expensive than other machining methods. Today, however, modern grinding machines allow intricate parts to be produced faster and more accurately than even conventional machining. Toolmakers, therefore, are turning to grinding operations to manufacture parts where high accuracy and surface finish are required.

Presentation Outline:

I. Define Types and Uses of Precision Grinders
  A. Surface
    1. Horizontal with reciprocating or rotary motion table

    - 2. Vertical with reciprocating or rotary motion table
  - B. Cylindrical
    - 1. Center type (universal)
    - 2. Centerless
  - C. Universal tool and cutter
- II. Discuss Grinding Safety
- III. Identify Major Components and Accessories of Grinding Machines
  - A. Hydraulic surface grinder
    - 1. Major Components
      - a. Base
      - b. Saddle
      - c. Table
      - d. Column
    - 2. Accessories
      - a. Magnetic chuck
      - b. Chuck blocks
      - c. Sine chuck
      - d. Adapter plate
      - e. Angle plate
      - f. Diamond dresser
  - B. Cylindrical grinder
    - 1. Major Components
      - a. Base
      - b. Wheelhead
      - c. Table
      - d. Headstock
      - e. Footstock
      - f. Work rest blade (centerless)
      - g. Regulating wheel (centerless)
    - 2. Accessories
      - a. Backrest or steadyrest
      - b. Center rest
      - c. Internal grinding attachment
  - C. Tool and cutter grinder
    - 1. Major components
      - a. Base
      - b. Wheelhead
      - c. Saddle
      - d. Table
    - 2. Accessories and attachments
      - a. Headstock
      - b. Footstock
      - c. Centering gage
      - d. Tooth rest
      - e. Tooth rest blade

f. Mandrel

IV. Identify Types, Nomenclature, and Uses of Grinding Wheels
  A. Abrasive Types
    1. Aluminum Oxide
    2. Silicon Carbide
  B. Grain Size
  C. Grade
  D. Structure
  E. Bond Type
  F. Shapes
V. Discuss the Procedures to Care and Maintain Grinding Wheels
  A. Inspecting
  B. Mounting
  C. Balancing
  D. Truing and dressing
VI. Identify the Factors Involved in Selecting Grinding Wheel Specifications
  A. Type of grinding operation
  B. Material to be ground
  C. Amount of stock to be removed
  D. Area of contact
  E. Finish required
  F. Wheel speed
  G. Method of cooling
VII. Explain Grinding Processes
  A. Surface grinding operations
    1. Squaring blocks (flat and edge grinding)
    2. Vertical surfaces
    3. Angular surfaces
    4. Form grinding
    5. Cutoff operations
  B. Cylindrical grinding operations
    1. Outside diameters
    2. Tapers
    3. Internal diameters
    4. Centerless grinding
  C. Tool and cutter grinder operations
    1. Cylindrical grinding
    2. Plain helical milling cutter
    3. End mill
    4. Side and face milling cutters
    5. Form-relieved cutter
VIII. Setup and Operate Grinding Machines (Surface, Cylindrical, and Tool and Cutter)

Practical Application:

Students should be given projects involving the above processes.

Evaluation and/or Verification:

Students should successfully complete the Practical Application above and the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-F7) dealing with operating heat treating equipment and processes.

TLD-F6-HO
Operate Precision Grinders
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this module the student will be able to:

a. Define types of precision grinders;
b. Discuss grinding safety;
c. Identify major components and accessories of grinding machines;
d. Identify types, nomenclature, and uses of grinding wheels;
e. Discuss care and maintenance of grinding wheels;
f. Identify the factors involved in electing grinding wheel specifications;
g. Explain grinding processes; and,
h. Setup and operate precision grinding machines.

Module Outline:

I. Define Types and Uses of Precision Grinders
  A. Surface
    1. Horizontal with reciprocating or rotary motion table
    2. Vertical with reciprocating or rotary motion table
  B. Cylindrical
    1. Center type (universal)
    2. Centerless
  C. Universal tool and cutter
II. Discuss Grinding Safety
III. Identify Major Components and Accessories of Grinding Machines
  A. Hydraulic surface grinder
    1. Major Components
      a. Base
      b. Saddle
      c. Table
      d. Column
    2. Accessories
      a. Magnetic chuck
      b. Chuck blocks
      c. Sine chuck
      d. Adapter plate
      e. Angle plate
      f. Diamond dresser
  B. Cylindrical grinder
    1. Major Components
      a. Base

- b. Wheelhead
- c. Table
- d. Headstock
- e. Footstock
- f. Work rest blade (centerless)
- g. Regulating wheel (centerless)
- 2. Accessories
- a. Backrest or steadyrest
- b. Center rest
- c. Internal grinding attachment
- C. Tool and cutter grinder
- 1. Major components
- a. Base
- b. Wheelhead
- c. Saddle
- d. Table
- 2. Accessories and attachments
- a. Headstock
- b. Footstock
- c. Centering gage
- d. Tooth rest
- e. Tooth rest blade
- f. Mandrel
- IV. Identify Types, Nomenclature, and Uses of Grinding Wheels
- A. Abrasive Types
- 1. Aluminum Oxide
- 2. Silicon Carbide
- B. Grain Size
- C. Grade
- D. Structure
- E. Bond Type
- F. Shapes
- V. Discuss the Procedures to Care and Maintain Grinding Wheels
- A. Inspecting
- B. Mounting
- C. Balancing
- D. Truing and dressing
- VI. Identify the Factors Involved in Selecting Grinding Wheel Specifications
- A. Type of grinding operation
- B. Material to be ground
- C. Amount of stock to be removed
- D. Area of contact
- E. Finish required
- F. Wheel speed
- G. Method of cooling

VII. Explain Grinding Processes
  A. Surface grinding operations
    1. Squaring blocks (flat and edge grinding)
    2. Vertical surfaces
    3. Angular surfaces
    4. Form grinding
    5. Cutoff operations
  B. Cylindrical grinding operations
    1. Outside diameters
    2. Tapers
    3. Internal diameters
    4. Centerless grinding
  C. Tool and cutter grinder operations
    1. Cylindrical grinding
    2. Plain helical milling cutter
    3. End mill
    4. Side and face milling cutters
    5. Form-relieved cutter

VIII. Setup and Operate Grinding Machines (Surface, Cylindrical, and Tool and Cutter)

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and,
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

Name:________________________ Date:____________________

TLD-F6
Operate Precision Grinders
Self-Assessment

1. List and discuss the types of precision grinders.

2. Discuss grinding safety.

3. List the major components of the three types of grinding machines.

4. List some accessories of the three types of grinding machines.

5. Name two materials used to make grinding wheels.

6. Why is grain size important?

7. What bond type is most common in grinding wheels?

8. What factors are involved in selecting a grinding wheel for an application?

9. Select the proper grinding wheel to square grind a piece of SAE 1045 to a 63 finish using a straight wheel with coolant.

10. Explain how to inspect a grinding wheel for cracks before mounting.

11. Explain how to true and dress a grinding wheel using a diamond dresser.

12. Explain the steps to square grind a block to a specific size.

13. Explain the steps to grind a part at a precise angle.

14 Explain the steps to grind a shaft to a specific diameter.

15 Explain centerless grinding.

16 Explain how to sharpen an end mill on a tool and cutter grinder.

TLD-F7

TOOL & DIE and EDM SERIES

MASTER Technical Module No. TLD-F7

Subject: **Tool & Die and EDM** **Time: 10 Hrs.**

Duty: **Demonstrate Knowledge of Manufacturing Processes**
Task: Operate Heat Treating Equipment and Processes

Objective(s):

Upon completion of this module the student will be able to:

a. Define heat treatment;
b. Identify types of heat treating equipment;
c. Identify the three major steps for all heat-treatment processes;
d. Explain heat treating processes and procedures;
e. Explain the terms relevant to heat treatment processes; and,
f. Set-up and operate heat treating equipment.

Instructional Materials:

MASTER Handout (TLD-F7-HO)
MASTER Laboratory Aid (TLD-F7-LA)
MASTER Self-Assessment

References:

Technology of Machine Tools, Steve Krar and Albert Check, Glencoe Publishing, Latest Edition

Machine Tool and Manufacturing Technology, Krar, Rapisarda, and Check, Delmar Publishers, Latest Edition

NTMA Machinist Training Program Module(s), National Tooling and Machining Association, 9399 Livingston Road, Fort Washington, MD 20744, Latest Edition

Instructor's Guide, Technology of Machine Tools, Amand, Krar, and Oswald, McGraw-Hill Publishers, Latest Edition

Workbook for Technology of Machine Tools, Amand, Krar, and Oswald, McGraw-Hill Publishers, Latest Edition

Modern Metalworking, John R. Walker , Goodheart-Willcox, Latest Edition

Metalwork; Technology and Practice, Victor E. Repp, Glencoe Publishing, Latest Edition

Machining Fundamentals, John R. Walker , Goodheart-Willcox, Latest Edition

Manufacturing Processes Reference Guide, Todd, Allen, and Alting, Industrial Press, Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:

TLD-A1 through TLD-A6	"Practice Safety"
TLD-B1 through TLD-B5	"Apply Mathematical Concepts"
TLD-C1	"Interpret and Understand Basic Layout/Types of Drawings"
TLD-C2	"Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances"
TLD-C3	"Use and Apply Geometric Dimensioning and Tolerancing (GD&T)"
TLD-C4	"Demonstrate Traditional Mechanical Drafting and Sketching Techniques"
TLD-D1 through TLD-D3	"Demonstrate Knowledge of Manufacturing Materials"
TLD-E1 through TLD-E6	"Measure/Inspect"
TLD-F1	"Discuss Metal Cutting an Metal Cutting Tools"
TLD-F2	"Operate Metal Saws"
TLD-F3	"Operate Drill Presses and Tooling"
TLD-F4	"Operate Engine and Turret Lathes and Tooling"
TLD-F5	"Operate Vertical and Horizontal Mills and Tooling"
TLD-F6	"Operate Precision Grinders"

Introduction:

One of the most important mechanical properties of steel is its ability to be heat treated to improve certain characteristics and, therefore, its usefulness. Tools, die components, gages, and etc. must be hardened to resist wear and abrasion. Sometimes, toolmakers heat treat steel to soften it in order to improve ductility and machinability. In either case, a tool and die shop must have a thorough understanding of the heat treatment process. While this level of understanding requires years of experience to develop, students should become familiar with the basics and have the foundation to build upon.

Presentation Outline:

I. Define Heat Treatment
II. Identify Types of Heat Treating Equipment
III. Identify the Three Major Steps for All Heat-treatment Processes
  A. Heating
  B. Soaking
  C. Cooling

- IV. Explain Heat Treating Processes and Procedures
  - A. Hardening
    - 1. Hardening temperature
    - 2. Quenching and quenching solutions
    - 3. Factors affecting hardness
  - B. Tempering, or drawing
    - 1. Need for tempering
    - 2. Tempering temperatures (and factors)
    - 3. Procedure
  - C. Annealing
    - 1. Need for annealing
    - 2. Types of annealing (and procedures)
      - a. Full annealing
      - b. Process annealing
      - c. Spheroidizing annealing
  - D. Normalizing
    - 1. Normalizing temperature
    - 2. Procedure
  - E. Other methods of heat treatment
    - 1. Case-hardening
      - a. Methods
      - b. Hardening
    - 2. Flame Hardening
    - 3. Induction Hardening
    - 4. Laser and electron beam hardening
- V. Explain the Terms Relevant to Heat Treatment Processes
  - A. Pearlite
  - B. Cementite
  - C. Austenite
  - D. Martensite
  - E. Troosite, sorbite, or tempered martensite
  - F. Eutectoid Steel
  - G. Hypereutectoid steel
  - H. Hypoeutectoid steel
  - I. Decalescence point
  - J. Recalescence point
  - K. Lower critical temperature point
  - L. Upper critical temperature point
  - M. Critical range
  - N. Body-centered cube
  - O. Face-centered cube
- VI. Set-Up and Operate Heat Treating Equipment

Practical Application:

If feasible, students should be given projects involving the above processes. If not, as many examples as possible will be very helpful.

Evaluation and/or Verification:

Students should successfully complete the Practical Application above and the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-F8) dealing with operating sheet metal equipment.

TLD-F7-HO
Operate Heat Treating Equipment and Processes
Attachment 1: **MASTER** Handout

Objective(s):

Upon completion of this module the student will be able to:

a. Define heat treatment;
b. Identify types of heat treating equipment;
c. Identify the three major steps for all heat-treatment processes;
d. Explain heat treating processes and procedures;
e. Explain the terms relevant to heat treatment processes; and,
f. Set-up and operate heat treating equipment.

Module Outline:

I. Define Heat Treatment
II. Identify Types of Heat Treating Equipment
III. Identify the Three Major Steps for All Heat-treatment Processes
    A. Heating
    B. Soaking
    C. Cooling
IV. Explain Heat Treating Processes and Procedures
    A. Hardening
        1. Hardening temperature
        2. Quenching and quenching solutions
        3. Factors affecting hardness
    B. Tempering, or drawing
        1. Need for tempering
        2. Tempering temperatures (and factors)
        3. Procedure
    C. Annealing
        1. Need for annealing
        2. Types of annealing (and procedures)
            a. Full annealing
            b. Process annealing
            c. Spheroidizing annealing
    D. Normalizing
        1. Normalizing temperature
        2. Procedure
    E. Other methods of heat treatment
        1. Case-hardening
            a. Methods
            b. Hardening

        2. Flame Hardening
        3. Induction Hardening
        4. Laser and electron beam hardening

V. Explain the Terms Relevant to Heat Treatment Processes
    A. Pearlite
    B. Cementite
    C. Austenite
    D. Martensite
    E. Troosite, sorbite, or tempered martensite
    F. Eutectoid Steel
    G. Hypereutectoid steel
    H. Hypoeutectoid steel
    I. Decalescence point
    J. Recalescence point
    K. Lower critical temperature point
    L. Upper critical temperature point
    M. Critical range
    N. Body-centered cube
    O. Face-centered cube

VI. Set-Up and Operate Heat Treating Equipment

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and,
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

Name:________________________ Date:____________________

TLD-F7
Operate Heat Treating Equipment and Processes
Self-Assessment

1. Define heat treatment.

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2. Explain the use of the thermocouple and pyrometer.

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3. Define soaking.

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4. List the principle kinds of heat treatment.

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5. Explain how medium- or high-carbon tool steel is hardened.

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6. Name three ways the hardening temperature of steel can be determined.

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7. List four factors that affect the hardness.

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8. List four kinds of quenching solutions and identify which cools most rapidly and which cools most slowly.

9. What is the purpose of tempering?

10. What factors must be considered in deciding what tempering temperature to use?

11. When should hardened steel be tempered?

12. List three kinds of annealing processes and explain the purpose of each kind.

13. Explain how full annealing is done.

14. Define normalizing and explain how it is done.

15. Define case-hardening and list the two steps.

16. List three kinds of case-hardening methods.

17. Briefly explain flame hardening and induction hardening.

18. Define pearlite, cementite, austenite, and martensite.

19. What is the difference between the decalescence point and the recalescence point of a piece of steel?

20. Define lower critical point and upper critical point.

21. At what point in relation to the upper and lower critical temperatures is hardening performed?

22. At what point in relation to the upper and lower critical temperatures is tempering performed?

23. Define critical range.

24. **Explain the difference between eutectoid, hypereutectoid, and hypoeutectoid steel.**

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25. **Describe the arrangement of atoms in a body- and a face-centered cube.**

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TOOL & DIE and EDM SERIES

MASTER Technical Module No. TLD-F8

Subject: **Tool & Die and EDM** **Time: 4 Hrs.**

Duty: **Demonstrate Knowledge of Manufacturing Processes**
Task: Operate Sheet Metal Equipment

Objective(s):

Upon completion of this module the student will be able to:
a. Discuss fabrication of sheet metal parts;
b. Discuss gas/plasma cutting equipment and processes;
c. Discuss shearing operation and equipment;
d. Discuss pressworking processes;
e. Demonstrate sheet metal layout; and,
f. Apply conservation-of-material concepts.

Instructional Materials:

MASTER Handout (TLD-F8-HO)
MASTER Laboratory Aid (TLD-F8-LA)
MASTER Self-Assessment

References:

Technology of Machine Tools, Steve Krar and Albert Check, Glencoe Publishing, Latest Edition
Machine Tool and Manufacturing Technology, Krar, Rapisarda, and Check, Delmar Publishers, Latest Edition
NTMA Machinist Training Program Module(s), National Tooling and Machining Association, 9399 Livingston Road, Fort Washington, MD 20744, Latest Edition
Instructor's Guide, Technology of Machine Tools, Amand, Krar, and Oswald, McGraw-Hill Publishers, Latest Edition
Workbook for Technology of Machine Tools, Amand, Krar, and Oswald, McGraw-Hill Publishers, Latest Edition
Modern Metalworking, John R. Walker , Goodheart-Willcox, Latest Edition
Metalwork; Technology and Practice, Victor E. Repp, Glencoe Publishing, Latest Edition
Machining Fundamentals, John R. Walker , Goodheart-Willcox, Latest Edition

Manufacturing Processes Reference Guide, Todd, Allen, and Alting, Industrial Press, Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:

TLD-A1 through TLD-A6	"Practice Safety"
TLD-B1 through TLD-B5	"Apply Mathematical Concepts"
TLD-C1	"Interpret and Understand Basic Layout/Types of Drawings"
TLD-C2	"Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances"
TLD-C3	"Use and Apply Geometric Dimensioning and Tolerancing (GD&T)"
TLD-C4	"Demonstrate Traditional Mechanical Drafting and Sketching Techniques"
TLD-D1 through TLD-D3	"Demonstrate Knowledge of Manufacturing Materials"
TLD-E1 through TLD-E6	"Measure/Inspect"
TLD-F1	"Discuss Metal Cutting and Metal Cutting Tools"
TLD-F2	"Operate Metal Saws"
TLD-F3	"Operate Drill Presses and Tooling"
TLD-F4	"Operate Engine and Turret Lathes and Tooling"
TLD-F5	"Operate Vertical and Horizontal Mills and Tooling"
TLD-F6	"Operate Precision Grinders"
TLD-F7	"Operate Heat Treating Equipment and Processes"

Introduction:

An important part of manufacturing can be classified as sheet metal operations. Many tools and all dies are for use in sheet metal processes. In addition, toolmakers will certainly find, from time to time, that they need to utilize certain sheet metal processes in building tools and dies. This necessitates an understanding of sheet metal fundamentals by tool and die makers. The intent of this module is simply to introduce sheet metal operations to tool and die students and give them working definitions of these processes.

Presentation Outline:

I. Discuss Fabrication of Sheet Metal Parts
    A. Sheet metal definition
    B. Sheet metal sizes
    C. Pattern development
    D. Hems, edges, and seams
II. Discuss Gas Cutting Equipment

    A. Oxygen-acetylene gas torch
    B. Plasma torch (nitrogen and oxygen)
    C. Single and gantry types
    D. Control methods
        1. Tracer and "Electric Eye"
        2. CNC
III. Discuss Shearing Operations and Equipment
IV. Discuss Pressworking Processes
    A. Punch press
    B. CNC turret punch press
    C. Press brake
    D. Roll forming machine
V. Discuss Sheet Metal Layout
    A. Templates
    B. Layout-on-metal
VI. Discuss Conservation-of-Material Concepts

Practical Application:

If feasible, students should be given simple projects involving the above processes. If not, as many examples as possible will be very helpful.

Evaluation and/or Verification:

Students should successfully complete the Practical Application above and the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-F9) dealing with operating welding equipment and processes.

TLD-F8-HO
Operate Sheet Metal Equipment
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this module the student will be able to:

- a. Discuss fabrication of sheet metal parts;
- b. Discuss gas/plasma cutting equipment and processes;
- c. Discuss shearing operation and equipment;
- d. Discuss pressworking processes;
- e. Demonstrate sheet metal layout; and,
- f. Apply conservation-of-material concepts.

Module Outline:

- I. Discuss Fabrication of Sheet Metal Parts
  - A. Sheet metal definition
  - B. Sheet metal sizes
  - C. Pattern development
  - D. Hems, edges, and seams
- II. Discuss Gas Cutting Equipment
  - A. Oxygen-acetylene gas torch
  - B. Plasma torch (nitrogen and oxygen)
  - C. Single and gantry types
  - D. Control methods
    - 1. Tracer and "Electric Eye"
    - 2. CNC
- III. Discuss Shearing Operations and Equipment
- IV. Discuss Pressworking Processes
  - A. Punch press
  - B. CNC turret punch press
  - C. Press brake
  - D. Roll forming machine
- V. Discuss Sheet Metal Layout
  - A. Templates
  - B. Layout-on-metal
- VI. Discuss Conservation-of-Material Concepts

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

Name:______________________ Date:______________________

TLD-F8
Operate Sheet Metal Equipment
Self-Assessment

1. Define sheet metal

2. Discuss how sheet metal is sized.

3. How thick is 10 ga. material?

4. Explain the pattern layout for a cylinder.

5. What is a hem?

6. What is a bend allowance and how is it used?

7. What is the difference between a plasma torch and an oxy-acetylene torch?

8. Explain what is meant by a gantry system.

9. What must you have to use a tracer or "electric eye" burner?

10. Explain the use of CNC controls on a CNC burner.

11. Explain how you could use a plate shear to cut a square plate.

12. What is the difference between a punch press and a brake press?

13. Which would you use to form large cone from a sheet metal pattern?

14. What is a hand brake?

15. Explain the term "die" as it relates to a press brake and a punch press.

16. Explain the purpose of the turret on a CNC turret punch press.

17. Explain the use of templates in sheet metal work.

18. Explain the term "nesting."

19. Why is layout-on-metal often necessary?

20. Explain the steps necessary to cut and make a rectangular box (in one piece) from a 12 ga. sheet.

TOOL & DIE and EDM SERIES

MASTER Technical Module No. TLD-F9

Subject: **Tool & Die and EDM** **Time: 4 Hrs.**

Duty: **Demonstrate Knowledge of Manufacturing Processes**
Task: Operate Sheet Metal Equipment

Objectives:

Upon completion of this module the student will be able to:
a. Discuss welding safety;
b. Identify and discuss types of welds;
c. Identify and discuss weld joints;
d. Identify and interpret weld symbols;
e. Identify and discuss welding processes;
f. Discuss weld characteristics; and,
g. Discuss edge preparation and fit-up.

Instructional Materials:

MASTER Handout (TLD-F9-HO)
MASTER Laboratory Aid (TLD-F9-LA)
MASTER Self-Assessment

References:

Welding Skills, Giachino and Weeks, American Technical Publishers, Latest Edition
Instructor's Guide, Welding Skills, Giachino and Weeks, American Technical Publishers, Latest Edition
Workbook for Welding Skills, Jonathan Gosse, American Technical Publishers, Latest Edition
Welding: Principles and Practices, Raymond J. Sacks, Glencoe Publishing, Latest Edition
Technology of Machine Tools, Steve Krar and Albert Check, Glencoe Publishing, Latest Edition
Machine Tool and Manufacturing Technology, Krar, Rapisarda, and Check, Delmar Publishers, Latest Edition
Welding Principles and Applications, Larry Jeffus, Delmar Publishing, Latest Edition
Modern Welding, Althouse, Turnquist, Bowditch, and Bowditch, Goodheart-Willcox, Latest Edition

Manufacturing Processes Reference Guide, Todd, Allen, and Alting, Industrial Press, Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:

TLD-A1 through TLD-A6	"Practice Safety"
TLD-B1 through TLD-B5	"Apply Mathematical Concepts"
TLD-C1	"Interpret and Understand Basic Layout/Types of Drawings"
TLD-C2	"Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances"
TLD-C3	"Use and Apply Geometric Dimensioning and Tolerancing (GD&T)"
TLD-C4	"Demonstrate Traditional Mechanical Drafting and Sketching Techniques"
TLD-D1 through TLD-D3	"Demonstrate Knowledge of Manufacturing Materials"
TLD-E1 through TLD-E6	"Measure/Inspect"
TLD-F1	"Discuss Metal Cutting and Metal Cutting Tools"
TLD-F2	"Operate Metal Saws"
TLD-F3	"Operate Drill Presses and Tooling"
TLD-F4	"Operate Engine and Turret Lathes and Tooling"
TLD-F5	"Operate Vertical and Horizontal Mills and Tooling"
TLD-F6	"Operate Precision Grinders"
TLD-F7	"Operate Heat Treating Equipment and Processes"
TLD-F8	"Operate Sheet Metal Equipment"

Introduction:

Welding is an important manufacturing process used in manufacturing today. It is one of the principle means of fabricating and repairing metal products. Many times, welding is used on tooling either as the fastener of choice or in repair. Although tool and die makers are typically recognized for their machining skills, it is important that they know the basics of welding technology.

Presentation Outline:

I. Discuss Welding Safety
II. Identify and Discuss Types of Welds
    A. Surfacing weld
    B. Fillet weld
    C. Groove weld
    D. Plug and slot weld
III. Identify and Discuss Weld Joints

- A. Butt joint
- B. Tee joint
- C. Lap joint
- D. Corner joint
- E. Edge joint

IV. Identify and Interpret Weld Symbols

V. Identify and Discuss Welding Processes
  - A. Oxyacetylene welding (OAW)
  - B. Arc Welding
    - 1. Shielded Metal-Arc Welding (SMAW)
    - 2. Gas Shielded-Arc Welding (GTAW and GMAW)
  - C. Other Welding Processes
    - 1. Brazing
    - 2. Surfacing
    - 3. Pipe Welding
    - 4. Cutting Operations
    - 5. Resistance

VI. Discuss Weld Characteristics
  - A. Penetration
  - B. Defects
  - C. Residual Stresses
  - D. Distortion

VII. Discuss Edge Preparation and Fit-up

Practical Application:

Students should be shown examples of as many of the above welds, joints, and processes as feasible. Students should then demonstrate basic OAW, SMAW, and GMAW.

Evaluation and/or Verification:

Students should successfully complete the Practical Application above and the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-F10) dealing with estimating time required and cost to produce a part.

TLD-F9-HO
Operate Welding Equipment and Processes
Attachment 1: MASTER Handout

Objectives:

Upon completion of this module the student will be able to:

a. Discuss welding safety;
b. Identify and discuss types of welds;
c. Identify and discuss weld joints;
d. Identify and interpret weld symbols;
e. Identify and discuss welding processes;
f. Discuss weld characteristics; and,
g. Discuss edge preparation and fit-up.

Module Outline:

I. Discuss Welding Safety
II. Identify and Discuss Types of Welds
    A. Surfacing weld
    B. Fillet weld
    C. Groove weld
    D. Plug and slot weld
III. Identify and Discuss Weld Joints
    A. Butt joint
    B. Tee joint
    C. Lap joint
    D. Corner joint
    E. Edge joint
IV. Identify and Interpret Weld Symbols
V. Identify and Discuss Welding Processes
    A. Oxyacetylene welding (OAW)
    B. Arc Welding
        1. Shielded Metal-Arc Welding (SMAW)
        2. Gas Shielded-Arc Welding (GTAW and GMAW)
    C. Other Welding Processes
        1. Brazing
        2. Surfacing
        3. Pipe Welding
        4. Cutting Operations
        5. Resistance
VI. Discuss Weld Characteristics
    A. Penetration
    B. Defects

  C. Residual Stresses
  D. Distortion

VII. Discuss Edge Preparation and Fit-up

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and,
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

Name:______________________ Date:______________________

TLD-F9
Operate Welding Equipment and Processes
Self-Assessment

1. What precautions must be taken before cutting or welding a container?

2. List eight safety precautions for cutting.

3. List three basic safety rules for oxyacetylene equipment.

4. List eight safety precautions or warnings for arc welding and arc welding equipment.

5. List and explain four types of welds.

6. List and describe the five basic types of weld joints.

7. Draw the weld symbol for a 1/4" fillet weld opposite side 1" long 4" pitch.

8. What are the principle components of oxyacetylene welding?

9. Briefly explain the basic procedure for OAW.

10. What is unique about the acetylene hose connector and how can you distinguish it from the oxygen connector?

11. What are the principle components of a SMAW welding process?

12. What basic principles can be used to sustain a stable arc?

13. How does the appearance of the molten puddle and weld bead indicate a good or poor weld?

14. What is an undercut? What is an overlap?

15. Briefly explain the GTAW process.

16. What is the purpose of the tungsten electrode in a TIG process?

17. What are the principle components of the GMAW process?

18. Describe the characteristics of a good weld.

19. Discuss residual stress and distortion from the welding process.

20. Very briefly explain the basics of the following welding processes: brazing, surfacing, and pipe welding.

TOOL & DIE and EDM SERIES
MASTER Technical Module No. TLD-F10

Subject: **Tool & Die and EDM** **Time: 4 Hrs.**

Duty: **Demonstrate Knowledge of Manufacturing Processes**
Task: Estimate Time Required/Cost to Produce a Part

Objective(s):

Upon completion of this module the student will be able to:
a. Determine component parts and requirements for assembly;
b. Determine processes required to produce piece parts;
c. Determine the material requirements and costs;
d. Determine tooling required;
e. Estimate time required to manufacture and assemble parts; and,
f. Estimate manufacturing costs.

Instructional Materials:

MASTER Handout (TLD-F10-HO)
MASTER Laboratory Aid (TLD-F10-LA)
MASTER Self-Assessment

References:

Technology of Machine Tools, Steve Krar and Albert Check, Glencoe Publishing, Latest Edition
Machine Tool and Manufacturing Technology, Krar, Rapisarda, and Check, Delmar Publishers, Latest Edition
NTMA Machinist Training Program Module(s), National Tooling and Machining Association, 9399 Livingston Road, Fort Washington, MD 20744, Latest Edition
Instructor's Guide, Technology of Machine Tools, Amand, Krar, and Oswald, McGraw-Hill Publishers, Latest Edition
Workbook for Technology of Machine Tools, Amand, Krar, and Oswald, McGraw-Hill Publishers, Latest Edition
Modern Metalworking, John R. Walker , Goodheart-Willcox, Latest Edition
Metalwork; Technology and Practice, Victor E. Repp, Glencoe Publishing, Latest Edition
Machining Fundamentals, John R. Walker , Goodheart-Willcox, Latest Edition

Fundamentals of Machine Tool Technology and Manufacturing Processes, C. Thomas Olivo, Delmar Publishing, Latest Edition

Advanced Machine Tool Technology and Manufacturing Processes, C. Thomas Olivo, Delmar Publishing, Latest Edition

Application of Metal Cutting Theory, Freyderyk E. Gorczyaca, Industrial Press, Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:

TLD-A1 through TLD-A6	"Practice Safety"
TLD-B1 through TLD-B5	"Apply Mathematical Concepts"
TLD-C1	"Interpret and Understand Basic Layout/Types of Drawings"
TLD-C2	"Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances"
TLD-C3	"Use and Apply Geometric Dimensioning and Tolerancing (GD&T)"
TLD-C4	"Demonstrate Traditional Mechanical Drafting and Sketching Techniques"
TLD-D1 through TLD-D3	"Demonstrate Knowledge of Manufacturing Materials"
TLD-E1 through TLD-E6	"Measure/Inspect"
TLD-F1	"Discuss Metal Cutting and Metal Cutting Tools"
TLD-F2	"Operate Metal Saws"
TLD-F3	"Operate Drill Presses and Tooling"
TLD-F4	"Operate Engine and Turret Lathes and Tooling"
TLD-F5	"Operate Vertical and Horizontal Mills and Tooling"
TLD-F6	"Operate Precision Grinders"
TLD-F7	"Operate Heat Treating Equipment and Processes"
TLD-F8	"Operate Sheet Metal Equipment"
TLD-F9	"Operate Welding Equipment and Processes"

Introduction:

Many times tool and die makers are asked to make time, cost, or material estimates for the manufacture of a particular part. These estimates are sometimes used to make price quotations, schedule production, order stock material, or predetermine tooling or personnel requirements.

Presentation Outline:

I. Determine Component Parts and Requirements for Assembly
II. Determine Processes Required to Produce Piece Parts
    A. Considerations

    1. Shape and size
    2. Fit and form tolerances and specifications
    3. Safety factors
  B. Order of operations
  C. Buy vs. make
    1. Capabilities
    2. Workload
III. Determine the Material Requirements and Costs
  A. Stock material
    1. Types and sizes
    2. Quantity required
      a. Finished quantity
      b. Machining excess
      c. Scrap factor
      d. Material conservation techniques
    3. Calculating material costs
      a. Cost per unit
      b. Total amount required
      c. Freight costs
      d. Overhead
  B. Purchased components
IV. Determine Tooling Required
  A. Fixtures, jigs, vices, etc.
  B. Cutting tools
  C. Lubrication/coolant requirements
  D. Additional resources required
V. Estimate Manufacturing Time
  A. Setup
    1. Lot size
    2. Tooling
    3. Rigidity
  B. Cycle time
    1. Speeds and feeds
    2. Depth of cut
  C. Tool life
  D. Handling time
    1. Transport
    2. Load/unload
  E. Personal allowance time
VI. Estimate Manufacturing Costs (MLO)
  A. Material
  B. Labor
  C. Overhead

Practical Application:

Students should be given problems and exercises to calculate time, material, and manufacturing costs.

Evaluation and/or Verification:

Students should successfully complete the Practical Application above and the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-G1) dealing with using computer operating systems.

TLD-F10-HO
Estimate Time Required/Cost to Produce a Part
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this module the student will be able to:
a. Determine component parts and requirements for assembly;
b. Determine processes required to produce piece parts;
c. Determine the material requirements and costs;
d. Determine tooling required;
e. Estimate time required to manufacture and assemble parts; and,
f. Estimate manufacturing costs.

Module Outline:

I. Determine Component Parts and Requirements for Assembly
II. Determine Processes Required to Produce Piece Parts
  A. Considerations
    1. Shape and size
    2. Fit and form tolerances and specifications
    3. Safety factors
  B. Order of operations
  C. Buy vs. make
    1. Capabilities
    2. Workload
III. Determine the Material Requirements and Costs
  A. Stock material
    1. Types and sizes
    2. Quantity required
      a. Finished quantity
      b. Machining excess
      c. Scrap factor
      d. Material conservation techniques
    3. Calculating material costs
      a. Cost per unit
      b. Total amount required
      c. Freight costs
      d. Overhead
  B. Purchased components
IV. Determine Tooling Required
  A. Fixtures, jigs, vices, etc.
  B. Cutting tools
  C. Lubrication/coolant requirements

    - D. Additional resources required
- V. Estimate Manufacturing Time
    - A. Setup
        - 1. Lot size
        - 2. Tooling
        - 3. Rigidity
    - B. Cycle time
        - 1. Speeds and feeds
        - 2. Depth of cut
    - C. Tool life
    - D. Handling time
        - 1. Transport
        - 2. Load/unload
    - E. Personal allowance time
- VI. Estimate Manufacturing Costs (MLO)
    - A. Material
    - B. Labor
    - C. Overhead

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and,
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

Name:________________________ Date:____________________

TLD-F10
Estimate Time Required/Cost to Produce a Part
Self-Assessment

1. Using Project #8 in the student workbook, list the component parts that make up the Drilling and Tapping Fixture assembly.

2. List in order the processes required to manufacture Part #5. Assume there are no restrictions because of workload or capabilities and that out-sourcing is unfeasible.

3. If the material for part #5 cost $1.00/lb (freight included), what is the total material cost, including machining excess and scrap quantity?

4. What tooling will be required to manufacture part #5?

5. In determining whether to buy or make in-house, what factors are to be considered?

6. In determining manufacturing time, what factors are to be considered?

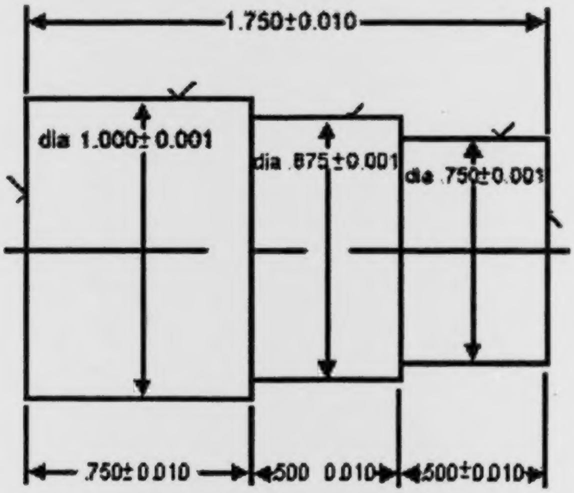
7. In determining setup time per piece, what factors are to be considered?

8. **In determining cycle time, what factors are to be considered?**

9. **In determining manufacturing costs, what factors are to be considered?**

10. **Estimate the MLO for the part below, using the following guidelines:**

Material	Machine Steel	Shop Rate	$50/hr
Stock Size	1.000" Dia.	Overhead	5%
Mat. Cost:	$1.00/lb.	Lot size	100


1.750±0.010
dia 1.000±0.001
dia .875±0.001
dia .750±0.001
.750±0.010
.500 0.010
.500±0.010

TOOL AND DIE MAKER .... skilled workers who produce tools, dies, and special guiding and holding devices that are used in machining.

	Duties	Tasks												
A	Practice Safety	A-1 Follow safety manuals and all safety regulations/requirements	A-2 Maintain safe equipment and machinery	A-3 Use safe operating procedures for hand and machine tools	A-4 Maintain a clean and safe work environment	A-5 Use safe material handling practices	A-6 Consult and apply MSDS for hazards of various materials							
B	Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Perform basic algebraic operations	B-3 Use basic geometric principles	B-4 Perform basic trigonometric functions	B-5 Use and apply Cartesian Coordinate System								
C	Interpret Engineering Drawings and Related Documents	C-1 Interpret and understand basic layout/types of drawings	C-2 Interpret, review, and apply blueprint notes, dimensions, and tolerances	C-3 Use and apply Geometric Dimensioning and Tolerancing (GD&T)	C-4 Demonstrate traditional mechanical drafting and sketching techniques	C-5 Understand and use quality systems								
D	Demonstrate Knowledge of Manufacturing Materials	D-1 Identify materials with desired properties	D-2 Identify materials and processes to produce a part	D-3 Discuss classification systems for metal										
E	Measure/ Inspect	E-1 Understand metrology terms	E-2 Select measurement tools	E-3 Measure with hand held instruments	E-4 Eliminate measurement variables	E-5 Measure/inspect using surface plate and accessories	E-6 Inspect using stationary equipment							
F	Demonstrate Knowledge of Manufacturing Processes	F-1 Discuss metal cutting and metal cutting tools	F-2 Operate metal saws	F-3 Operate drill presses and tooling	F-4 Operate engine and turret lathes and tooling	F-5 Operate vertical and horizontal mills and tooling	F-6 Operate precision grinders	F-7 Operate heat treating equipment and processes	F-8 Operate sheet metal equipment	F-9 Operate welding equipment and processes	F-10 Estimate time required/ cost to produce a part			
G	Use Computers	G-1 Use computer operating systems	G-2 Understand computer terminology	G-3 Use file management systems	G-4 Install and use software packages									
H	Perform CAD/ CAM and CNC Programming Tasks	H-1 Discuss fundamentals of CNC machines and controls	H-2 Program and operate CNC milling machine and machining center	H-3 Program and operate CNC lathe	H-4 Use Computer-Aided Drafting (CAD) system	H-5 Create 3-D solid models	H-6 Use Computer-Aided Manufacturing (CAM) system							
I	Perform Tool and Die Making Operations	I-1 Discuss basic types and functions of jigs and fixtures	I-2 Utilize concepts of jig and fixture design	I-3 Demonstrate understanding of different types of industrial dies	I-4 Utilize basic die theory	I-5 Utilize principles of die design	I-6 Perform tool and die repair	I-7 Demonstrate tool and die making skills						
J	Operate Electrical Discharge Machine (EDM)	J-1 Discuss fundamentals of EDM	J-2 Setup and operate conventional sinker EDM	J-3 Program, setup, and operate CNC sinker EDM and EDM drill	J-4 Program, setup, and operate CNC wire EDM									

TOOL & DIE and EDM SERIES

MASTER Technical Module No. TLD-G1

Subject: Tool & Die and EDM **Time:** 10 Hrs.

Duty: Use Computers
Task: Use Computer Operating Systems

Objective(s):

Upon completion of this module the student will be able to:

a. Distinguish between a directory/file folder and a file;
b. Understand data organization and terminology;
c. Explain the function of an operating system;
d. Explain what the term "IBM compatible" means;
e. Use a mouse;
f. Utilize file manager in Windows 3.1 to view directories and files;
g. Utilize explorer in Windows 95 to view folders and files; and,
h. Explain and use basic network concepts.

Instructional Materials:

Data Disks with files
MASTER Handout (TLD-G1-HO)
MASTER Laboratory Worksheets (TLD-G1-LW1; TLD-G1-LW2; TLD-G1-LW3)
MASTER Self-Assessment

References:

Windows 3.1 and/or *Windows 95 Computer Lab*, Latest Edition
Introduction to Using Windows 3.1, Latest Edition
Introduction to Using Windows 95, Latest Edition
Introduction to Using Networks, Latest Edition

Student Preparation:

None

Introduction:

Technicians are like all other people in today's workplace. They must be able to use the computer as a tool to get their work done. In order to use computers effectively, it is

important that one understands components and operating systems as they relate to the use of a computer. This module will introduce the student to these concepts and provide a foundation for developing good basic skills in the use of a computer.

Presentation Outline:

I. Introduction to Computers
    A. Discuss hardware components
    B. Explain disk drive configurations
    C. Discuss software
        1. Application programs
        2. Operating systems
            a. DOS
            b. Windows
            c. Windows 95
            d. Network operating systems
    D. Discuss brands of computers
        1. Apple & MacIntosh
        2. IBM & compatibles
    E. Explain data organization
        1. Files
        2. Filenames and extensions
        3. Root directory & backward slash (\)
        4. Directory and subdirectory structure
    F. Explain the terms directory path and file specification
II. Introduction to the Windows Operating System
    A. Discuss how to start Windows
    B. Discuss basic mouse operations
        1. Pointing
        2. Clicking
        3. Double clicking
        4. Dragging
    C. Discuss Windows elements
        1. Window borders
        2. Title bar
        3. Control-menu box
        4. Mouse pointer
        5. Sizing buttons
        6. Scroll bar and arrows
        7. Menu bar
        8. Pull-down menus
        9. Work area
        10. Icons
    D. Use File Manager

    - 1. Explain the file manager screen
    - 2. Change drives
    - 3. Expand directories
    - 4. Collapse directories
    - 5. Change file information displayed
    - 6. Run an application
  - E. Run an application from an icon in Program Manager
- III. Introduction to Windows 95 Operating System
  - A. Discuss Windows 95 desktop components
    - 1. My Computer icon
    - 2. Recycle Bin icon
    - 3. Network Neighborhood icon
    - 4. Start button
    - 5. Taskbar
  - B. Use Windows 95
    - 1. Open a window from an icon
    - 2. Use sizing buttons and close button
    - 3. Discuss Start menu
    - 4. Open an application using the Start button
    - 5. Explain shut down menu under Start
    - 6. Use Windows Explorer
      - a. Explain Windows Explorer toolbar buttons
      - b. Explain folders and subfolders
      - c. Select folders
      - d. Open and close folders
      - e. Change drives
      - f. Change file list display
- IV. Introduction to Computer Network Systems
  - A. Explain what a network is
  - B. Discuss basic network components
    - 1. File server
    - 2. Network operating system (NOS)
    - 3. Local area network (LAN) cable
    - 4. Network devices
  - C. Explain types of networks
    - 1. Campus
    - 2. National
    - 3. International
  - D. Explain and use basic network concepts
    - 1. File server login/logout
    - 2. Application sharing
    - 3. Document sharing
    - 4. Electronic mail

Practical Application:

Students will use Windows 3.1, Windows 95, and a NOS by completing the Laboratory Worksheets labeled TLD-G1-LW1, TLD-G1-LW2, and TLD-G1-LW3.

Evaluation and/or Verification:

Successful completion of this technical module will be determined by the student's ability to successfully demonstrate the following competencies:

1. Explain the function of an operating system;
2. Define terminology associated with data organization;
3. Explain the term "IBM compatible;"
4. Define terminology associated with basic network concepts;
5. Use File Manager in Windows to view the directory structure of a disk, to view the contents of a directory, and to change the display of a file list; and,
6. Use Windows Explorer in Windows 95 to view the directory structure of a disk, to view the contents of a directory, and to change the display of a file list.

Summary:

Review the concepts covered in this module in preparation for the self-assessment.

Next Lesson Assignment:

MASTER Technical Module (TLD-G2) dealing with understanding computer terminology.

TLD-G1-HO
Use Computer Operating Systems
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this module the student will be able to:

- a. Distinguish between a directory/file folder and a file;
- b. Understand data organization and terminology;
- c. Explain the function of an operating system;
- d. Explain what the term "IBM compatible" means;
- e. Use a mouse;
- f. Utilize file manager in Windows 3.1 to view directories and files;
- g. Utilize explorer in Windows 95 to view folders and files; and,
- h. Explain and use basic network concepts.

Module Outline:

- I. Introduction to Computers
  - A. Discuss hardware components
  - B. Explain disk drive configurations
  - C. Discuss software
    - 1. Application programs
    - 2. Operating systems
      - a. DOS
      - b. Windows
      - c. Windows 95
      - d. Network operating systems
  - D. Discuss brands of computers
    - 1. Apple & MacIntosh
    - 2. IBM & compatibles
  - E. Explain data organization
    - 1. Files
    - 2. Filenames and extensions
    - 3. Root directory & backward slash (\)
    - 4. Directory and subdirectory structure
  - F. Explain the terms directory path and file specification
- II. Introduction to the Windows Operating System
  - A. Discuss how to start Windows
  - B. Discuss basic mouse operations
    - 1. Pointing
    - 2. Clicking
    - 3. Double clicking
    - 4. Dragging

- C. Discuss Windows elements
  - 1. Window borders
  - 2. Title bar
  - 3. Control-menu box
  - 4. Mouse pointer
  - 5. Sizing buttons
  - 6. Scroll bar and arrows
  - 7. Menu bar
  - 8. Pull-down menus
  - 9. Work area
  - 10. Icons
- D. Use File Manager
  - 1. Explain the file manager screen
  - 2. Change drives
  - 3. Expand directories
  - 4. Collapse directories
  - 5. Change file information displayed
  - 6. Run an application
- E. Run an application from an icon in Program Manager

III. Introduction to Windows 95 Operating System

- A. Discuss Windows 95 desktop components
  - 1. My Computer icon
  - 2. Recycle Bin icon
  - 3. Network Neighborhood icon
  - 4. Start button
  - 5. Taskbar
- B. Use Windows 95
  - 1. Open a window from an icon
  - 2. Use sizing buttons and close button
  - 3. Discuss Start menu
  - 4. Open an application using the Start button
  - 5. Explain shut down menu under Start
  - 6. Use Windows Explorer
    - a. Explain Windows Explorer toolbar buttons
    - b. Explain folders and subfolders
    - c. Select folders
    - d. Open and close folders
    - e. Change drives
    - f. Change file list display

IV. Introduction to Computer Network Systems

- A. Explain what a network is
- B. Discuss basic network components
  - 1. File server
  - 2. Network operating system (NOS)
  - 3. Local area network (LAN) cable

   4. Network devices

C. Explain types of networks
   1. Campus
   2. National
   3. International

D. Explain and use basic network concepts
   1. File server login/logout
   2. Application sharing
   3. Document sharing
   4. Electronic mail

TLD-G1-LW1
Use Computer Operating Systems
Attachment 2: MASTER Laboratory Worksheet No. 1

Introduction to Using Windows 3.1

1. Double-click the Main Group and open the File Manager. Click Tree and choose Indicate Expandable Branches, if it has not been selected. What lets you know this selection has been made? What does this selection do?

   ____

2. Select the root of drive C. Choose Tree from the command bar. Then clock Collapse Branch. What does this selection do?

   ____

3. Choose Tree again and click Expand One Level. How many directories/folders are on drive C?

   ____

4. In the command bar, select Tree and choose Expand All. What happened?

   ____

5. Find the folder WPWIN. How many subdirectories/subfolders are listed under the directory/folder name TEMPLATE?

   ____

6. Double-click a directory/folder that contains a subdirectory/subfolder. What happened?

   ____

7. What happens if you double-click the folder again?

   ____

8. Place a disk in drive A. How can you view the contents of the file in drive A?

   ____

9. Select drive C again. Under View, choose All File Details. What happened?

   ____

10. Select the MACROS subdirectory/subfolder under WPWIN. Go to View and choose Sort by Name. What is the first file listed?________________________

    Sort by Type. The first file listed is ________________________________

Sort by Size. The first file listed is ______________________________

Sort by Date. The first file listed is ______________________________

11. How can the list of files in a particular folder be viewed?

____

12. Exit File Manager and close the Main Group. How did you do this?

____

13. How could an application package, such as WordPerfect for Windows, be loaded and run from Windows 3.1?

____

TLD-G1-LW2
Use Computer Operating Systems
Attachment 3: **MASTER** Laboratory Worksheet No. 2

Introduction to Using Windows 95

1. Click Start, go to Programs, and click Windows Explorer.

2. Maximize the window, if necessary.

3. Click in the square to the left of the My Computer icon.

4. What does a + in the square mean? What happens when you click the +?

   ____

5. What does a - in the square mean? What happens when you click the -?

   ____

6. Click on C:. How many directories/folders are at the root of drive C? How many files are at the root of drive C?

   ____

7. Expand drive C. How may directories under drive C are expandable?

   ____

8. How do you expand and collapse directories/folders?

   ____

9. Click View and select Details, what happened?

   ____

10. Put a disk in drive A and select drive A. How many directories/folders and files are at the root of drive A?

    ____

11. Select drive C again and open the DOS folder. How can you sort the file list by name, type, size, or date?

    ____

12. Exit Explorer. How did you do this?

    ____

13. **How do you run an application package, such as WordPerfect, from Windows 95?**

TLD-G1-LW3
Using Computer Operating Systems
Attachment 4: **MASTER** Laboratory Worksheet No. 3

Introduction to Using Networks

1. Locate the file server? Where is it?

2. What type of NOS is being used in this lab?

3. How do you login to the file server? What is the purpose of this?

4. Can you send an e-mail message in this lab? If so, what steps must be taken to do this?

5. What type of "sharing" can be done?

6. How can the directory structure of the file server be viewed?

7. Logout of the network. What is the purpose of this?

Name:______________________________ **Date:**________________________

TLD-G1
Use Computer Operating Systems
Self-Assessment

1. Explain the function of an operating system?

2. What does the term "IBM compatible" mean?

3. Create your own names for directories/folders and files to design a directory structure containing three directories at the root. The first directory is to hold two files and one subdirectory. The second directory is to hold two subdirectories with one file in each subdirectory. The third directory should contain five files.

4. What is a directory/folder?

5. What does the term "path" mean?

6. What is a file specification?

7. What does the backward slash (\) represent?

8. What is a network and what are the basic network components?

9. What do the acronyms NOS and LAN stand for?

10. What is the purpose of logging into a network?

11. What is the purpose of logging out of a network?

12. What is meant by application sharing?

13. What is meant by document sharing?

14. What is electronic mail?

THE FOLLOWING QUESTIONS CONCERN WINDOWS 3.1.

15. When using Windows 3.1, how can the directory structure of a disk be viewed?

16. Using Windows 3.1, write how to do each of the following:

   a. View the directory contents of a different drive

   b. Expand and collapse a directory

   c. Change the file information displayed

17. How do you run an application such as Lotus 123 or WordPerfect from Windows 3.1?

18. What are the rules for naming files in Windows 3.1?

THE FOLLOWING QUESTIONS CONCERN WINDOWS 95.

19. When using Windows 95 how can the directory structure of a disk be viewed?

20. Using Windows 95, write how to do each of the following:

a. Open and close a folder

b. View directory contents of a different drive

c. Change the file list display

21. How can directories/folders be distinguished from files?

22. How do you run an application, such as Lotus 123, from Windows 95?

TLD-G2

TOOL & DIE and EDM SERIES

MASTER Technical Module No. TLD-G2

Subject: **Tool & Die and EDM** **Time: 4 Hrs.**

Duty: **Use Computers**
Task: Understand Computer Terminology

Objective(s):

Upon completion of this unit the student will be able to:

a. Explain what RAM is;
b. Explain what ROM is;
c. Explain memory caching;
d. Define and convert bytes, kilobytes, and megabytes;
e. Discuss the function of a central processing unit;
f. Discuss processor speed; and,
g. Understand RS-232 protocol.

Instructional Materials:

MASTER Handout (TLD-G2-HO)
MASTER Self-Assessment

References:

Student Preparation:

Students should have previously completed the following technical modules:
TLD-G1 "Use Computer Operating Systems"

Introduction:

In order for the technicians to maximize the use of the computer and its related software, it is important that they have a conceptual understanding of how information and data are managed and processed within the computer. This module will introduce the student to the computer's brain, memory, and basic design for getting things done that are of value to the user.

Presentation Outline:

- I. Explain What Memory Is
  - A. RAM
  - B. ROM
  - C. Cache memory
  - D. Measuring memory
    - 1. Byte
    - 2. Kilobyte
    - 3. Megabyte
- II. Discuss Purpose and Function Of:
  - A. Central Processing Units (CPUs)
  - B. Processor performance
    - 1. Speed
    - 2. Generation
    - 3. Type
  - C. RS-232 serial port
- III. Determine the Amount of Available Memory on a System
  - A. Choose About from the Help menu in Program Manager for Windows 3.1
  - B. Choose About from the Help menu in Windows Explorer for Windows 95

Evaluation and/or Verification:

Successful completion of this technical module will be determined by the student's ability to successfully demonstrate the following competencies:

1. Define RAM and explain its function;
2. Define ROM and explain its function;
3. Explain the value of memory caching;
4. Explain the function of the CPU;
5. Determine the faster processor speed and explain what determines the speed;
6. Convert between bytes, kilobytes, and megabytes; and,
7. Explain the significance of a RS-232 serial port.

Summary:

Review the concepts covered in this module in preparation for the self-assessment.

Next Lesson Assignment:

MASTER Technical Module (TLD-G3) dealing with the use of file management systems.

TLD-G2-HO
Understand Computer Terminology
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Explain what RAM is;
b. Explain what ROM is;
c. Explain memory caching;
d. Define and convert bytes, kilobytes, and megabytes;
e. Discuss the function of a central processing unit;
f. Discuss processor speed; and,
g. Understand RS-232 protocol.

Module Outline:

I. Explain What Memory Is
  A. RAM
  B. ROM
  C. Cache memory
  D. Measuring memory
    1. Byte
    2. Kilobyte
    3. Megabyte
II. Discuss Purpose and Function Of:
  A. Central Processing Units (CPUs)
  B. Processor performance
    1. Speed
    2. Generation
    3. Type
  C. RS-232 serial port
III. Determine the Amount of Available Memory on a System
  A. Choose About from the Help menu in Program Manager for Windows 3.1
  B. Choose About from the Help menu in Windows Explorer for Windows 95

Name:________________________ Date:______________________

TLD-G2
Understand Computer Terminology
Self-Assessment

1. What is RAM and explain its function.

____

____

2. What is ROM and explain its function.

____

____

3. What does the term "memory caching" mean?

____

____

4. What is the function of the CPU?

____

____

5. Circle the faster processor speed and explain why it is faster.

   a. 33-MHz 80486 or 20-MHz 80486

   b. 20-MHz 80486 or 33-MHz 80386

____

____

6. **Fill in the blanks below.**

1800 bytes = ______ KB

2 KB = ______ bytes

4 megabytes = ______ bytes

500 MB = ______ kilobytes

1,000,000 bytes = ______ megabytes

3300 kilobytes = ______ MB

7. **What is the significance of a RS-232 serial port?**

____

____

TOOL & DIE and EDM SERIES

MASTER Technical Module No. TLD-G3

Subject: Tool & Die and EDM **Time:** 10 Hrs.

Duty: Use Computers
Task: Use File Management Systems

Objectives:

Upon completion of this unit the student will be able to:
a. Explain file management concepts;
b. Create and delete directories/folders;
c. Copy a file(s) from one directory to another;
d. Copy a file(s) between a floppy disk and a hard drive;
e. Rename, move, and delete a file(s); and,
f. Format disks and make system disks.

Instructional Materials:

Data Disks
MASTER Handout (TLD-G3-HO)
MASTER Laboratory Worksheets(TLD-G3-LW1; TLD-G3-LW2)
MASTER Self-Assessment

References:

Windows 3.1 and/or *Windows 95 Computer Lab*, Latest Edition
Using Windows 3.1 to Perform File Management Operations, Latest Edition
Using Windows 95 to Perform File Management Operations, Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:
TLD-G1 "Use Computer Operating Systems"
TLD-G2 "Understand Computer Terminology"

Introduction:

The understanding of files, file management systems, and the storage of files becomes important when one has entered information into the computer for processing. Since this is often a time consuming process in manufacturing, it becomes even more important that one understand the concepts. This module focuses on the development of competencies related to file management systems.

Presentation Outline:

- I. Explain and Discuss File Management Concepts
  - A. Copying a file(s)
  - B. Deleting a file(s)
  - C. Moving a file(s)
  - D. Renaming a file(s)
  - E. Creating a directory
  - F. Deleting a directory
  - G. Copying a disk
  - H. Formatting a disk
  - I. Making a system disk
- II. Use File Manager in Windows 3.1 to Perform File Management Operations
  - A. Use the file menu to:
    - 1. Create a directory
      - a. On the hard drive
      - b. On a floppy disk
    - 2. Copy a file(s)
      - a. From one directory to another
      - b. From a floppy disk to the hard drive
      - c. From the hard drive to a floppy disk
    - 3. Move a file(s)
    - 4. Rename a file(s)
    - 5. Delete a file(s)
    - 6. Delete a directory
  - B. Use the disk menu to:
    - 1. Copy a disk
    - 2. Format a disk
    - 3. Make a system disk
- III. Use Windows 95 to Perform File Management Operations
  - A. Use the file menu in Windows Explorer to:
    - 1. Create a new folder on the hard drive
    - 2. Create a new folder on the floppy drive
  - B. Use the edit menu in Windows Explorer to:
    - 1. Copy a file(s) from one directory to another
    - 2. Copy a file(s) from a floppy disk to the hard drive
    - 3. Copy a file(s) from the hard drive to a floppy disk
    - 3. Cut a file(s)
    - 4. Paste a file(s)
  - C. Use the file menu in Windows Explorer to:

   1. Rename a file(s)
   2. Delete a file(s)
   3. Delete a folder

D. Use My Computer on the Windows 95 desktop to:
   1. Format a disk
   2. Make a system disk

Practical Application:

Students will use Windows 3.1 and Windows 95 to complete the Laboratory Worksheets TLD-G3-LW1 and TLD-G3-LW2.

Evaluation and/or Verification:

Successful completion of this technical module will be determined by the student's ability to successfully demonstrate the following competencies in Windows 3.1 and/or Windows 95:

1. Create a directory/folder on a hard drive and a floppy disk;
2. Copy files from the hard drive to a floppy disk and from a floppy disk to a hard drive;
3. Rename a file;
4. Move a file;
5. Delete a file;
6. Delete a directory; and,
7. Format a system disk.

Summary:

Review the concepts covered in this module in preparation for the self-assessment.

Next Lesson Assignment:

MASTER Technical Module (TLD-G4) which deals with installing and using software packages.

TLD-G3-HO
Use File Management Systems
Attachment 1: MASTER Handout

Objectives:

Upon completion of this unit the student will be able to:

a. Explain file management concepts;
b. Create and delete directories/folders;
c. Copy a file(s) from one directory to another;
d. Copy a file(s) between a floppy disk and a hard drive;
e. Rename, move, and delete a file(s); and,
f. Format disks and make system disks.

Module Outline:

I. Explain and Discuss File Management Concepts
  A. Copying a file(s)
  B. Deleting a file(s)
  C. Moving a file(s)
  D. Renaming a file(s)
  E. Creating a directory
  F. Deleting a directory
  G. Copying a disk
  H. Formatting a disk
  I. Making a system disk
II. Use File Manager in Windows 3.1 to Perform File Management Operations
  A. Use the file menu to:
    1. Create a directory
      a. On the hard drive
      b On a floppy disk
    2. Copy a file(s)
      a. From one directory to another
      b. From a floppy disk to the hard drive
      c. From the hard drive to a floppy disk
    3. Move a file(s)
    4. Rename a file(s)
    5. Delete a file(s)
    6. Delete a directory
  B. Use the disk menu to:
    1. Copy a disk
    2. Format a disk
    3. Make a system disk
III. Use Windows 95 to Perform File Management Operations

A. Use the file menu in Windows Explorer to:
  1. Create a new folder on the hard drive
  2. Create a new folder on the floppy drive
B. Use the edit menu in Windows Explorer to:
  1. Copy a file(s) from one directory to another
  2. Copy a file(s) from a floppy disk to the hard drive
  3. Copy a file(s) from the hard drive to a floppy disk
  3. Cut a file(s)
  4. Paste a file(s)
C. Use the file menu in Windows Explorer to:
  1. Rename a file(s)
  2. Delete a file(s)
  3. Delete a folder
D. Use My Computer on the Windows 95 desktop to:
  1. Format a disk
  2. Make a system disk

TLD-G3-LW1
Use File Management Systems
Attachment 2: **MASTER** Laboratory Worksheet No. 1

Using Windows 3.1 to Perform File Management Operations

*** A DATA DISK WILL BE NEEDED TO COMPLETE THESE EXERCISES. ***

1. Open the Main window and start File Manager.
2. Maximize the directory tree window.
3. View the contents of drive A and create a directory called RAINBOW.
4. View the contents of the hard drive by selecting the root icon for drive C.
5. Expand the directory named WINDOWS and view the files in the SYSTEM subdirectory.
6. Sort the files in SYSTEM by size and select the four smallest files.
7. Copy these files to the RAINBOW directory on drive A.
8. Check to see that these four files are still in the SYSTEM subdirectory. Now, view the contents of the RAINBOW directory on drive A to make sure the files were copied.
9. Rename each of the files under RAINBOW on drive A as Red, Blue, Green, and Yellow.
10. Create another directory on drive A named COLORS.
11. Move the files Red and Green from RAINBOW to COLORS.
12. Check to see that RAINBOW now contains only the files named Blue and Yellow.
13. Check to see that COLORS contains two files named Red and Green.
14. Delete the Yellow file in the RAINBOW directory.
15. Delete the RAINBOW directory.

16. Create a directory on the hard drive named your first name.

17. Copy the files on the disk in drive A to the directory on the hard drive with your name.

18. Format your data disk and then view its contents.

19. Make a system disk with your data disk. Use this system disk to restart the computer.

TLD-G3-LW2
Use File Management Systems
Attachment 3: **MASTER** Laboratory Worksheet No. 2

Using Windows 95 to Perform File Management Operations

*** A DATA DISK WILL BE NEEDED TO COMPLETE THESE EXERCISES. ***

1. Click START and choose Windows Explorer under Programs.

2. Maximize this window.

3. View the contents of your data disk in drive A and create a folder named SAMPLE on your data disk.

4. View the contents of the hard drive by selecting the root icon for drive C.

5. Expand the WINDOWS folder and view the files in the HELP subdirectory.

6. View the details of the files and arrange the files by size.

7. Select the four smallest files and copy them to the SAMPLE folder on drive A.

8. Check to see that these four files are still in the HELP folder on the hard drive. Now, view the contents of the SAMPLE folder on drive A to make sure the files were copied.

9. Rename each of the files under SAMPLE on drive A as File1, File2, File3, and File4.

10. Create another folder on drive A named EXERCISE.

11. Move the files File1 and File3 under SAMPLE to the folder named EXERCISE.

12. Check to see that SAMPLE now contains the files named File2 and File4.

13. Check to see that EXERCISE contains File1 and File3.

14. Delete File2 in SAMPLE.

15. Delete the folder SAMPLE.

16. Create a folder on the hard drive named PRACTICE.

17. Copy the files on the disk in drive A to the PRACTICE folder on the hard drive.

18. Format your data disk. Does it still contain your files?

19. Make your data disk a system disk. Explain the value of having a system disk.

Name:______________________________ Date:________________________

TLD-G3
Use File Management Systems
Self-Assessment

Use Windows 3.1 or Windows 95 to perform the following operations. You will need two data disks. Please turn in *both* disks to the instructor when you have completed the following tasks.

1. Create a directory/folder on the hard drive using TEST as the directory/folder name.

2. Copy any three files from the hard drive into TEST.

3. Create a directory/folder on one of your data disks using MINE as the directory/folder name.

4. Move the three files in TEST on the hard drive to MINE on the floppy disk.

5. In the MINE directory/folder, rename each of the files as File1, File2, and File3.

6. Copy File1, File2, and File3 to the TEST directory/folder on the hard drive.

7. Delete File1 in the MINE directory/folder on the data disk.

*** ASK THE INSTRUCTOR TO WATCH AS YOU PERFORM TASK #8. ***

8. Delete the TEST directory/folder on the hard drive.

9. Use a second data disk to make a system disk.

10. What is a system disk?

    ____

    ____

TOOL & DIE and EDM SERIES

MASTER Technical Module No. TLD-G4

Subject: **Tool & Die and EDM** **Time: 40 Hrs.**

Duty: **Use Computers**
Task: Install and Use Software Packages

Objectives:

Upon completion of this unit the student will be able to:

a. Install a software package to a hard disk;
b. Configure the system parameters upon installation;
c. Create a word processing document;
d. Create a spreadsheet; and,
e. Open, edit, enhance, save, and print word processing and spreadsheet files.

Instructional Materials:

Data Disks
Creating a Word Processing Document
Creating a Spreadsheet
MASTER Laboratory Worksheets (TLD-G4-LW1; TLD-G4-LW2)
MASTER Self-Assessment

References:

Windows 3.1 and/or *Windows 95 Computer Lab,* Latest Edition
Software package to install from CD
Software package to install from diskettes
Word processing software
Spreadsheet software

Student Preparation:

Students should have previously completed the following Technical Modules:

MLD-G1 "Use Computer Operating Systems"
MLD-G2 "Understand Computer Terminology"
MLD-G3 "Use File Management Systems"

Introduction:

In order to process data, computers need a set of instructions to tell it what to do. These instructions are called programs. Since technicians will want to use programs that perform certain tasks, it is important that they understand how to install, configure, and use software. That is the purpose of this module.

Presentation Outline:

I. Explain How to Install Software Packages Using Windows 3.1
    A. Install from a CD-ROM
    B. Install from diskettes
II. Explain How to Install Software Packages Using Windows 95
    A. Install from a CD-ROM
    B. Install from diskettes
III. Explain How to Configure System Parameters for a Software Package
    A. Modification to AUTOEXEC.BAT and CONFIG.SYS
    B. Modification of INI files (e.g. WIN.INI, SYSTEM.INI)
    C. Plotter/printer driver configurations
    D. Digitizer pad/mouse driver configurations
IV. Use a Word Processor Software Package (e.g. WordPerfect, MS Word)
    A. Typing a document
    B. Using cursor movement keys
    C. Editing a document with backspace and delete
    D. Using the spelling checker
    E. Saving a file
    F. Printing a file
    G. Closing a file
    H. Opening a file
    I. Changing the margins
    J. Using bold, italics, and underline
    K. Changing alignment
V. Use a Spreadsheet Software Package (e.g. Lotus 123, MS Excel)
    A. Entering values and labels
    B. Editing the spreadsheet
    C. Using formulas and functions
    D. Changing column widths
    E. Changing number format
    F. Changing alignment
    G. Copying formulas and functions
    H. Printing the spreadsheet
    I. Saving the spreadsheet and chart

Practical Application:

Students can perform practical applications by installing software packages to a hard disk and answering system parameter prompts during the installation. Students will create word processing and spreadsheet documents by completing the Laboratory Worksheets TLD-G4-LW1 and TLD-G4-LW2.

Evaluation and/or Verification:

Successful completion of this technical module will be determined by the student's ability to successfully demonstrate the following competencies:

1. Install a software package and give proper system parameters;
2. Create, save, and print a word processing document; and,
3. Create, save, and print a spreadsheet.

Summary:

Review the concepts covered in this module in preparation for the self-assessment.

Next Lesson Assignment:

MASTER Technical Module (TLD-H1) dealing with fundamentals of CNC machines and controls.

TLD-G4-HO
Install and Use Software Packages
Attachment 1: **MASTER** Handout

Objectives:

Upon completion of this unit the student will be able to:

- a. Install a software package to a hard disk;
- b. Configure the system parameters upon installation;
- c. Create a word processing document;
- d. Create a spreadsheet; and,
- e. Open, edit, enhance, save, and print word processing and spreadsheet files.

Module Outline:

- I. Explain How to Install Software Packages Using Windows 3.1
  - A. Install from a CD-ROM
  - B. Install from diskettes
- II. Explain How to Install Software Packages Using Windows 95
  - A. Install from a CD-ROM
  - B. Install from diskettes
- III. Explain How to Configure System Parameters for a Software Package
  - A. Modification to AUTOEXEC.BAT and CONFIG.SYS
  - B. Modification of INI files (e.g. WIN.INI, SYSTEM.INI)
  - C. Plotter/printer driver configurations
  - D. Digitizer pad/mouse driver configurations
- IV. Use a Word Processor Software Package (e.g. WordPerfect, MS Word)
  - A. Typing a document
  - B. Using cursor movement keys
  - C. Editing a document with backspace and delete
  - D. Using the spelling checker
  - E. Saving a file
  - F. Printing a file
  - G. Closing a file
  - H. Opening a file
  - I. Changing the margins
  - J. Using bold, italics, and underline
  - K. Changing alignment
- V. Use a Spreadsheet Software Package (e.g. Lotus 123, MS Excel)
  - A. Entering values and labels
  - B. Editing the spreadsheet
  - C. Using formulas and functions
  - D. Changing column widths

E. **Changing number format**
F. **Changing alignment**
G. **Copying formulas and functions**
H. **Printing the spreadsheet**
I. **Saving the spreadsheet and chart**

TLD-G4-LW1
Install and Use Software Packages
Attachment 2: MASTER Laboratory Worksheet No. 1

Creating a Word Processing Document

I. Creating Documents

A. Key the following document in a word processing software package.

The Vernier Caliper
The basic parts of a vernier caliper are a main scale which is similar to a steel rule with a fixed jaw and a sliding jaw with a vernier scale. They are available in a wide range of lengths with different types of jaws and scale graduations.

B. Check your spelling.

C. Save the document on your data disk as CALIPERS and print.

D. Close the document.

E. Create another new document and enter the text below.

Micrometers
Micrometers are basic measuring instruments used by technicians in the processing and checking of parts. They are available in a wide range of sizes and types.

Outside micrometers are used to measure dimensions between parallel surfaces of parts and outside diameters of cylinders. Other types, such as depth micrometers, screw thread micrometers, disc and blade micrometers, and inside micrometers, also have wide application in the machine shop.

F. Boldface and italicize the title.

G. Change the top margin to 2.8 inches and check the spelling.

H. Save the document on your data disk under the name MICS and print.

I. Close the document.

II. Opening Documents and Editing

A. Open the document CALIPERS.

B. Insert Decimal-Inch in the title between "The" and "Vernier", so the title will read The Decimal-Inch Vernier Caliper. Also, boldface the title.

C. Insert the following text as the second sentence.

The vernier scale slides parallel to the main scale and provides a degree of precision to 0.001".

D. In the last sentence, change "They" to "Calipers".

E. Change the top margin to 2.7 inches and check your spelling.

F. Save under the same name and print.

G. Open the document MICS.

H. Make the two paragraphs one.

I. Save the document under the same name and print.

Creating a Spreadsheet

I. Create a Spreadsheet, Change Column Widths, and Alignment

A. Enter the following labels as shown below to create a spreadsheet. Change the column width as necessary.

Diametral Pitch	Number of Teeth	Pitch Diameter (inches)	Addendum (inches)	Dedendum (inches)

B. Center the labels in the cells.

C. In the Diametral Pitch column enter the following values: 4, 6, 8, and 3.

D. In the Number of Teeth column enter the following values: 45, 75, 44, and 54.

E. Save the spreadsheet to your data disk as BEVEL and print.

F. Open a new document and enter the following information below. Change the column widths as necessary.

Name	Rate	Hours	Gross Pay
Natalie Nicholson	6.80	40	
Dave Miller	8.60	40	
Karen Lark	8.60	38	
Taylor Smithsonian	5.50	20	

G. Center the values in the Hours column.

H. Set the number format in the Rate column to show two decimal places and the number format in the Hours column to show zero decimal places.

I. Save the spreadsheet to your data disk as PAYROLL and print.

II. Create and Copy Formulas/functions and Edit the Spreadsheet

A. Place BEVEL back on your desktop.

B. Enter the following formulas in the appropriate cell and copy to other cells where the formula is needed.

Pitch Diameter = Number of Teeth / Diametral Pitch
Dedendum = 1.157 / Diametral Pitch
Addendum = 1/ Diametral Pitch

C. Save under the same name and print.

D. Change the Diametral Pitch in the first cell from 4 to 5.

E. Change the Number of Teeth in the last cell from 54 to 50

F. Add a Diametral Pitch of 10 with the Number of Teeth given as 80.

G. Copy the formulas to the new row.

H. Save and print.

I. Place PAYROLL back on the desktop and enter the formula to compute the Gross Pay. (Gross Pay = Rate * Hours)

J. Format the Gross Pay as currency.

K. Add the Hours column.

L. Change Dave Miller's rate of pay to $9.00.

M. Save and print.

Name:________________________ Date:_____________________

TLD-G4
Install and Use Software Packages
Self-Assessment

1. Install the software package assigned to you by your instructor and give the proper system parameters.

2. Create the following word processing document.

(date)

Mr. Eric Brown
Director of Personnel
Mason Manufacturing Company
Crestview Drive
Franklin, MS 38801

Dear Mr. Brown:

I read your advertisement seeking a manufacturing technician for your company. Please consider this letter as my application for the position.

I received my Associate of Applied Science degree in Manufacturing Technology from Texas State Technical College in Waco, Texas. Presently I am a manufacturing technician. I have held this position for four years with Acme Tool and Die in Waco, Texas.

As a manufacturing technician I have had experience in conventional machine operations, CNC mill and CNC wire EDM operations, and CAM programming. I have just received my certification as a journeyman, but presently there are no positions available in my present place of employment.

Sincerely,

(your name)

Enclosure

3. Save the document on your data disk under the name MASON and print.

4. Boldface “manufacturing technician” in the first paragraph.

5. Add the following as the fourth paragraph:

   I have enclosed my resume which will supply you with more specific information about my background and present employment. I would very much appreciate an interview with you.

6. Save the document again and print.

7. Create the following spreadsheet. Right align the labels.

Circular Pitch (inches)	Working Depth (inches)	Clearance (inches)	Tooth Thickness (inches)
0.3925			
0.1582			
0.8069			
1.2378			
1.5931			

8. Enter the following formulas into the appropriate cell and use copy to place the formula in the other cells.

   Working depth = 0.6366 * Circular Pitch
   Clearance = 0.05 * Circular Pitch
   Tooth thickness = 0.5 * Circular Pitch

9. Save the spreadsheet as SPUR and print.

10. Change the last measurement in the Circular Pitch column to 1.1359.

11. Save the spreadsheet again and print.

TOOL AND DIE MAKER .... skilled workers who produce tools, dies, and special guiding and holding devices that are used in machining.

Duties ← **Tasks** →

A	Practice Safety	A-1 Follow safety manuals and all safety regulations/ requirements	A-2 Maintain safe equipment and machinery	A-3 Use safe operating procedures for hand and machine tools	A-4 Maintain a clean and safe work environment	A-5 Use safe material handling practices	A-6 Consult and apply MSDS for hazards of various materials							
B	Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Perform basic algebraic operations	B-3 Use basic geometric principles	B-4 Perform basic trigonometric functions	B-5 Use and apply Cartesian Coordinate System								
C	Interpret Engineering Drawings and Related Documents	C-1 Interpret and understand basic layout/types of drawings	C-2 Interpret, review, and apply blueprint notes, dimensions, and tolerances	C-3 Use and apply Geometric Dimensioning and Tolerancing (GD&T)	C-4 Demonstrate traditional mechanical drafting and sketching techniques	C-5 Understand and use quality systems								
D	Demonstrate Knowledge of Manufacturing Materials	D-1 Identify materials with desired properties	D-2 Identify materials and processes to produce a part	D-3 Discuss classification systems for metal										
E	Measure/ Inspect	E-1 Understand metrology terms	E-2 Select measurement tools	E-3 Measure with hand held instruments	E-4 Eliminate measurement variables	E-5 Measure/inspect using surface plate and accessories	E-6 Inspect using stationary equipment							
F	Demonstrate Knowledge of Manufacturing Processes	F-1 Discuss metal cutting and metal cutting tools	F-2 Operate metal saws	F-3 Operate drill presses and tooling	F-4 Operate engine and turret lathes and tooling	F-5 Operate vertical and horizontal mills and tooling	F-6 Operate precision grinders	F-7 Operate heat treating equipment and processes	F-8 Operate sheet metal equipment	F-9 Operate welding equipment and processes	F-10 Estimate time required/ cost to produce a part			
G	Use Computers	G-1 Use computer operating systems	G-2 Understand computer terminology	G-3 Use file management systems	G-4 Install and use software packages									
H	Perform CAD/ CAM and CNC Programming Tasks	H-1 Discuss fundamentals of CNC machines and controls	H-2 Program and operate CNC milling machine and machining center	H-3 Program and operate CNC lathe	H-4 Use Computer-Aided Drafting (CAD) system	H-5 Create 3-D solid models	H-6 Use Computer-Aided Manufacturing (CAM) system							
I	Perform Tool and Die Making Operations	I-1 Discuss basic types and functions of jigs and fixtures	I-2 Utilize concepts of jig and fixture design	I-3 Demonstrate understanding of different types of industrial dies	I-4 Utilize basic die theory	I-5 Utilize principles of die design	I-6 Perform tool and die repair	I-7 Demonstrate tool and die making skills						
J	Operate Electrical Discharge Machine (EDM)	J-1 Discuss fundamentals of EDM	J-2 Setup and operate conventional sinker EDM	J-3 Program, setup, and operate CNC sinker EDM and EDM drill	J-4 Program, setup, and operate CNC wire EDM									

TLD-H1

TOOL & DIE and EDM SERIES
MASTER Technical Module No. TLD-H1

Subject: **Tool & Die and EDM** **Time: 15 Hrs.**

Duty: **Perform CAD/CAM and CNC Programming Tasks**
Task: Discuss Fundamentals of CNC Machines and Controls

Objectives:

Upon completion of this module the student will be able to:
a. Identify and describe essentials and safety of CNC systems;
b. Identify and describe types of CNC hardware and software;
c. Identify and describe machine axes and coordinate systems; and,
d. Identify and describe coordinate systems.

Instructional Materials:

MASTER Handout (TLD-H1-HO)
MASTER Self-Assessment

References:

Computer Numerical Control, From Programming to Networking, S.C. Jonathan Lin, Delmar Publishers Inc., Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:

TLD-A1 through TLD-A6	"Practice Safety"
TLD-B1 through TLD-B5	"Apply Mathematical Concepts"
TLD-C1 through TLD-C5	"Interpret Engineering Drawings and Related Documents"
TLD-D1 through TLD-D3	"Demonstrate Knowledge of Manufacturing Materials"
TLD-E1 through TLD-E6	"Measure/Inspect"
TLD-F1 through TLD-F10	"Demonstrate Knowledge of Manufacturing Processes"
TLD-G1 through TLD-G4	"Use Computers"

Introduction:

In the modern world of machining more and more companies are relying heavily on CNC machinery. This is a trend that is expected to continue into the future of machine technology. Many students are highly motivated to learn how to program and operate this type of equipment. It is wise to have a basic understanding of how the equipment functions so we can have a better understanding of how to program the machine tool operations. Many of the procedures can be compared directly to their conventional machine counterparts. Most people will progress further along if they establish a solid foundation in the basic principles.

Presentation Outline:

I. Identify and Describe Essentials and Safety of CNC Systems
   A. Identify and explain essentials
      1. Define numerical control
      2. Explain history and future of CNC technology
      3. Identify basic elements of CNC system
      4. Define Computer Numerical Control (CNC)
      5. Explain advantages and limitations of CNC
      6. Identify applications of CNC technology
   B. Compare types of CNC systems
      1. Identify and describe modes on numerical control systems
      2. Explain difference between the following:
         a. Point-to-point
         b. Axial path
         c. 45° line type
         d. Linear path
         e. Continuous path
      3. Describe CNC interpolation
      4. Identify types of CNC interpolations
      5. Explain difference between open loop and closed loop systems
      6. List benefits and problems of open and closed loop systems
   C. Demonstrate safety practices related to CNC systems
      1. Demonstrate safety practices, including:
         a. Safety guard/door interlocks
         b. Power box interlocks
         c. Tool loading and unloading
         d. Loading and unloading work holding devices
         e. Machine coolant disposal
      2. Describe/identify personal safety equipment

II. Identify and Describe Types of CNC Hardware and Software
   A. Identify and describe CNC hardware
      1. Compare NC and CNC systems

        - 2. Identify components of CNC machine control unit (MCU)
        - 3. Define applications of operator control panel
        - 4. Explain functions of operator control panel
        - 5. Define utilities found on typical control panel
        - 6. Select appropriate CNC controls
    - B. Describe CNC software
        - 1. Describe software related to machine tool
        - 2. Describe applications of operation, interface and application software
        - 3. Describe interface of software and hardware
    - C. Explain feed back drive system
        - 1. Describe feed drive system
        - 2. Explain feed back mechanisms
        - 3. Compare direct and indirect measurement systems
- III. Identify and Describe Machine Axes and Coordinate Systems
    - A. Identify and describe machine axes
        - 1. Define and identify machine axes X, Y and Z
        - 2. Identify and describe linear axes using right hand rule
        - 3. Identify and define primary rotary axes A, B and C
    - B. Describe coordinate systems
        - 1. Describe Cartesian coordinate system as used in NC program
        - 2. Define relationship of Cartesian coordinate system with machine axes
    - C. Define characteristics of positioning systems
        - 1. Define application of absolute positioning systems
        - 2. Define application of incremental positioning systems
    - D. Define reference systems
        - 1. Describe characteristics of:
            - a. Machine reference coordinates
            - b. Work reference coordinates
            - c. Program reference coordinates
            - d. Fixtures offset coordinates
- IV. Describe and Interpret CNC Coding Systems
    - A. Interpret number bases
        - 1. Interpret decimal and binary bases
        - 2. Interpret octal and hexadecimal bases
    - B. Describe NC program storage media
        - 1. Describe the media
        - 2. Describe advantages and disadvantages of each media
    - C. Describe EIA and ASCII formatted tapes
        - 1. Describe EIA format on tapes
        - 2. Describe ASCII format on tapes
        - 3. Describe differences in EIA and ASCII formats

Practical Application:

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-H2) dealing with programming and operating CNC milling machine and machining center.

TLD-H1-HO
Discuss Fundamentals of CNC Machines and Controls
Attachment 1: MASTER Handout

Objectives:

Upon completion of this module the student will be able to:

- a. Identify and describe essentials and safety of CNC systems;
- b. Identify and describe types of CNC hardware and software;
- c. Identify and describe machine axes and coordinate systems; and,
- d. Identify and describe coordinate systems.

Module Outline:

- I. Identify and Describe Essentials and Safety of CNC Systems
  - A. Identify and explain essentials
    - 1. Define numerical control
    - 2. Explain history and future of CNC technology
    - 3. Identify basic elements of CNC system
    - 4. Define Computer Numerical Control (CNC)
    - 5. Explain advantages and limitations of CNC
    - 6. Identify applications of CNC technology
  - B. Compare types of CNC systems
    - 1. Identify and describe modes on numerical control systems
    - 2. Explain difference between the following:
      - a. Point-to-point
      - b. Axial path
      - c. 45° line type
      - d. Linear path
      - e. Continuous path
    - 3. Describe CNC interpolation
    - 4. Identify types of CNC interpolations
    - 5. Explain difference between open loop and closed loop systems
    - 6. List benefits and problems of open and closed loop systems
  - C. Demonstrate safety practices related to CNC systems
    - 1. Demonstrate safety practices, including:
      - a. Safety guard/door interlocks
      - b. Power box interlocks
      - c. Tool loading and unloading
      - d. Loading and unloading work holding devices
      - e. Machine coolant disposal
    - 2. Describe/identify personal safety equipment
- II. Identify and Describe Types of CNC Hardware and Software
  - A. Identify and describe CNC hardware

    - 1. Compare NC and CNC systems
    - 2. Identify components of CNC machine control unit (MCU)
    - 3. Define applications of operator control panel
    - 4. Explain functions of operator control panel
    - 5. Define utilities found on typical control panel
    - 6. Select appropriate CNC controls
  - B. Describe CNC software
    - 1. Describe software related to machine tool
    - 2. Describe applications of operation, interface and application software
    - 3. Describe interface of software and hardware
  - C. Explain feed back drive system
    - 1. Describe feed drive system
    - 2. Explain feed back mechanisms
    - 3. Compare direct and indirect measurement systems
- III. Identify and Describe Machine Axes and Coordinate Systems
  - A. Identify and describe machine axes
    - 1. Define and identify machine axes X, Y and Z
    - 2. Identify and describe linear axes using right hand rule
    - 3. Identify and define primary rotary axes A, B and C
  - B. Describe coordinate systems
    - 1. Describe Cartesian coordinate system as used in NC program
    - 2. Define relationship of Cartesian coordinate system with machine axes
  - C. Define characteristics of positioning systems
    - 1. Define application of absolute positioning systems
    - 2. Define application of incremental positioning systems
  - D. Define reference systems
    - 1. Describe characteristics of:
      - a. Machine reference coordinates
      - b. Work reference coordinates
      - c. Program reference coordinates
      - d. Fixtures offset coordinates
- IV. Describe and Interpret CNC Coding Systems
  - A. Interpret number bases
    - 1. Interpret decimal and binary bases
    - 2. Interpret octal and hexadecimal bases
  - B. Describe NC program storage media
    - 1. Describe the media
    - 2. Describe advantages and disadvantages of each media
  - C. Describe EIA and ASCII formatted tapes
    - 1. Describe EIA format on tapes
    - 2. Describe ASCII format on tapes
    - 3. Describe differences in EIA and ASCII formats

Name______________________________ Date:______________________

TLD-H1
Discuss Fundamentals of CNC Machines and Controls
Self-Assessment

Circle the letter preceding the correct answer.

1. The definition "a system in which actions are controlled by the insertion of numerical data at some point" refers to?
   A. Direct Numerical Control
   B. Distributive Numerical Control
   C. Numerical Control
   D. Computerized Numerical Control

2. Which company is given credit for creating the first numerical control milling machine?
   A. Rohr Industries
   B. Massachusetts Institute of Technology
   C. Parsons Corporations
   D. General Electric

3. The term CNC stands for?
   A. Continuous Numerical Control
   B. Centerline Numerical Control
   C. Computerized Numerical Control
   D. Computerized Numerical Counter

4. The term DNC has multiple definitions one is:
   A. Distinct numerical control
   B. Desired numerical control
   C. Direct numerical control
   D. Destination numerical control

5. The term DNC has multiple definitions another one is:
   A. District numerical control
   B. Distributive numerical control
   C. Distinctive numerical control
   D. Desired numerical control

6. Examples of basic elements of a CNC system would include:
   A. Center drill
   B. Milling cutters
   C. Mouse
   D. Part program

7. Examples of basic elements of a CNC system would include:
   - A. Anilam
   - B. Program input device
   - C. Pocket calculator
   - D. Coolant

8. Examples of basic elements of a CNC system would include:
   - A. Machine control unit
   - B. Outside micrometer
   - C. Pencil and paper
   - D. Basic understanding of mathematics

9. Examples of basic elements of a CNC system would include:
   - A. Barcoding system
   - B. Inside micrometer
   - C. Drive systems
   - D. Basic understanding of engineering drawings

10. Examples of basic elements of a CNC system would include:
   - A. Machine tool
   - B. Basic theory of metal removal
   - C. Dial calipers
   - D. Windows operating system

11. Examples of basic elements of a CNC system would include:
   - A. Clamping devices
   - B. Depth micrometers
   - C. Feedback systems
   - D. Fine surface finishes

12. NC systems are often referred to as:
   - A. Primary memory
   - B. Softwired
   - C. Hardwired
   - D. Secondary memory

13. CNC systems are often referred to as:
   - A. Primary memory
   - B. Softwired
   - C. Hardwired
   - D. Secondary memory

14. Examples of advantages of CNC would include:
A. High cost of cutting tools
B. Increased productivity
C. Highly attractive machines
D. More interesting for maintenance workers

15. Examples of advantages of CNC would include:
A. Lower number of pallets needed
B. Increased electronics
C. Inch and metric calibrations
D. High accuracy and repeatability

16. Examples of advantages of CNC would include:
A. Reduced production costs
B. Systems require less attention
C. Cost effective for small production runs
D. Lower maintenance requirements

17. Examples of advantages of CNC would include:
A. Reduced initial investment
B. Reduced indirect operating costs
C. Cost effective for small production runs
D. Lower maintenance requirements

18. CNC operators have to have a higher skill level then a precision tool maker
A. True
B. False

19. Examples of disadvantages (limitations) of CNC would include:
A. High cost of cutting tools
B. Higher productivity
C. High initial investment
D. High probability of human error

20. Examples of disadvantages (limitations) of CNC would include:
A. Higher scrap rates
B. Higher Maintenance requirements
C. Higher machine utilization
D. High probability of human error

21. Examples of disadvantages (limitations) of CNC would include:
A. Not cost effective for precision parts
B. Not cost effective for alloys
C. Not cost effective for low production levels
D. Not cost effective for non ferrous metals

22. CNC can only be applied to applications of chip removal.
    A. True
    B. False

23. The addition of CNC machines guarantees increased productivity.
    A. True
    B. False

24. CNC programming has been dramatically changed by the advent of:
    A. Fiber optics
    B. CAD/CAM
    C. Space age coolants
    D. Special applications

25. The Point to Point control system is most often used in _________ operations.
    A. Rough machining
    B. Pocket machining
    C. Drilling
    D. Contouring

26. The Continuous-Path control system is often called _______________ system.
    A. Rough machining
    B. Pocket machining
    C. Drilling
    D. Contouring

27. The Continuous-Path control system is limited since it can only move one axis at a time.
    A. True
    B. False

28. An example of a function of the CNC interpolator would include:
    A. Generates spindle speed calculations for efficient material removal
    B. Generates intermediate coordinate positions along the program path
    C. Generates the proper feed rate in program
    D. Generates a complete list of "G" codes as needed by the machine

29. An example of a function of the CNC interpolator would include:
    A. Computes coolant selections for machine tool as needed
    B. Computes separate tool changes as needed
    C. Computes individual axis velocities as needed
    D. Computes material finish requirements as needed

30. One example of a common interpolation would be:
 A. Metabolic
 B. Bicubic approximation
 C. Linear
 D. Helical cubic NURB

31. One example of a common interpolation would be:
 A. Eliptoidinal
 B. Bi nurdic eliptoidinal
 C. Radius
 D. Circular

32. One significant feature of the _______________ control system is that there is no feedback signal for checking whether the programmed position has been reached.
 A. Closed loop
 B. Open loop
 C. NC
 D. CNC

33. One significant feature of the _______________ control system is that there are feedback signals that check whether the programmed position has been reached.
 A. Closed loop
 B. Open loop
 C. NC
 D. CNC

34. The _______________ control system is usually used with the Point to Point systems.
 A. Closed loop
 B. Open loop
 C. NC
 D. CNC

35. The _______________ control system is usually used with Continuous Path systems.
 A. Closed loop
 B. Open loop
 C. NC
 D. CNC

36. The acronym MCU stands for:
   - A. Machine Companies Unification
   - B. Machine control unit
   - C. Machine control university
   - D. Machine control union

37. Examples of primary memory would include:
   - A. Floppy disks
   - B. Hard drives
   - C. RAM
   - D. Paper tape

38. Examples of primary memory would include:
   - A. Greco system
   - B. DNC
   - C. ROM
   - D. Punch cards

39. Examples of secondary memory would include:
   - A. Greco system
   - B. DNC
   - C. ROM
   - D. Hard drives

40. Examples of secondary memory would include:
   - A. Floppy disks
   - B. Greco system
   - C. RAM
   - D. Paper tape

41. Machine _____________ is what allows us to reach a exact desired point coordinate.
   - A. Controller
   - B. Repeatability
   - C. Accuracy
   - D. Programming

42. Machine _____________ is what allows us to come back to an exact point coordinate time after time.
   - A. Controller
   - B. Repeatability
   - C. Accuracy
   - D. Programming

43. The ________________ measurement feedback system is free from the effects of machine backlash.
A. Indirect
B. Direct
C. Closed loop
D. Open loop

44. The ________________ measurement feedback system is effected by machine backlash.
A. Indirect
B. Direct
C. Closed loop
D. Open loop

45. The ________________ measurement feedback system is more accurate.
A. Indirect
B. Direct
C. Closed loop
D. Open loop

46. The machine axis designation by X,Y, and Z are the ______________ machine axis.
A. Tertiary linear
B. Primary linear
C. Secondary linear
D. Primary rotary

47. The machine axis designation by A,B and C are the ______________ machine axis.
A. Tertiary rotary
B. Primary rotary
C. Secondary rotary
D. Primary linear

48. The Cartesian coordinate system is often referred to as the ________________ coordinate system.
A. Polar
B. Secondary
C. Rectangular
D. Primary

49. The data point X-1.0 Y-2.0 is located in the number ____________ quadrant.
   A. 1
   B. 2
   C. 3
   D. 4

50. The data point X 1.0 Y 2.0 is located in the number ____________ quadrant.
   A. 1
   B. 2
   C. 3
   D. 4

51. The data point X 1.0 Y- 2.0 is located in the number ___________ quadrant.
   A. 1
   B. 2
   C. 3
   D. 4

52. The data point X- 1.0 Y 2.0 is located in the number ___________ quadrant.
   A. 1
   B. 2
   C. 3
   D. 4

53. The ___________ coordinate system defines the position of a point by its radius and an angle of rotation.
   A. Polar
   B. Secondary
   C. Rectangular
   D. Primary

54. If a data point was rotated 100 degrees from 0 it would be in the number ___________ quadrant.
   A. 1
   B. 2
   C. 3
   D. 4

55. If a data point was rotated 295 degrees from 0 it would be in the number ___________ quadrant.
   A. 1
   B. 2
   C. 3
   D. 4

56. If a data point was rotated 40 degrees from 0 it would be in the number ___________ quadrant.

A. 1
B. 2
C. 3
D. 4

57. If a data point was rotated 195 degrees from 0 it would be in the number ___________ quadrant.

A. 1
B. 2
C. 3
D. 4

58. In the ___________ positioning system all positions are measured from a single fixed point.

A. Incremental
B. Polar
C. Rectangular
D. Absolute

59. In the ___________ positioning system, the reference point is not fixed and moves from data point to data point .

A. Incremental
B. Polar
C. Rectangular
D. Absolute

TLD-H1

Discuss Fundamentals of CNC Machines and Controls

Self-Assessment Answer Key

1.	D
2.	C
3.	C
4.	C
5.	B
6.	D
7.	B
8.	A
9.	C
10.	A
11.	C
12.	C
13.	B
14.	B
15.	D
16.	A
17.	B
18.	B
19.	C
20.	B
21.	C
22.	B
23.	B
24.	B
25.	C
26.	D
27.	B
28.	B
29.	C
30.	C
31.	D
32.	B
33.	A
34.	B
35.	A
36.	B
37.	C
38.	C
39.	D
40.	A
41.	C
42.	B
43.	B
44.	A
45.	B
46.	B
47.	B
48.	C
49.	C
50.	A
51.	D
52.	B
53.	A
54.	B
55.	B
56.	A
57.	C
58.	D
59.	A

TOOL & DIE and EDM SERIES

MASTER Technical Module No. TLD-H2

Subject: **Tool & Die and EDM** **Time: 50 Hrs.**

Duty: **Perform CAD/CAM and CNC Programming Tasks**
Task: Program and Operate CNC Milling Machine and Machining Center

Objectives:

Upon completion of this module the student will be able to:

a. Describe history of vertical machining;
b. Describe theory of operation;
c. Describe nomenclature used in vertical machining;
d. Demonstrate safety practices related to vertical machining centers;
e. Set-up and program operation of vertical machine;
f. Demonstrate proper machining of objects;
g. Create program using machine controllers software, and cycles;
h. Set-up and utilize three dimensional digitizer; and,
i. Maintain vertical machine.

Instructional Materials:

MASTER Handout (TLD-H2-HO)
MASTER Laboratory Exercise/Self-Assessment (TLD-H2-LE/SA)
MASTER Laboratory Aid (TLD-H2-LA)

References:

Computer Numerical Control, From Programming to Networking, S.C. Jonathan Lin, Delmar Publishers, Inc., Latest Edition
Programming and Operation Manuals for your CNC machine(s)

Student Preparation:

Students should have previously completed the following Technical Modules:
TLD-H1 "Discuss Fundamentals of CNC Machines and Controls"

Introduction:

With the introduction of the first NC machines, machining was changed forever. In the beginning, ownership of NC machines was limited to those companies that possessed great financial resources. The need for these machines, even if one had the capital, was limited to those companies that produced long production runs that required little (if any) design variation. These early machines were not user friendly nor were they quick to program, set up or operate. The advent of modern computers along with major changes in associated electronics has changed this scenario forever. Today the vast majority of companies have at least one CNC machine if not many. Most of the new employment is offered in the use and programming of these machines. It is no longer an option as to whether a technician wants to learn how to use a CNC machining center. The overall popularity of CNC machines is increasing dramatically and this trend demands that all technicians accept CNC as they have any other tool of their trade.

This module addresses the application of the CNC vertical machining center, which is really just a hybrid of the common milling machine, with the addition of many of its attachments.

This module can be used for individuals who will be using vertical machines at various levels from CNC operator to CNC technicians. The ability to complete these tasks both quickly and accurately in various settings will, in most cases, be one of the deciding factors of how long an individual will stay at the operator level or progress into the programming area.

Presentation Outline:

I. Describe Vertical Machining Process and Safety
  A. Describe History of Vertical Machining
    1. Describe proper use of various machines
  B. Describe Theory of Operation
    1. Describe open and closed loop systems
    2. Describe various oil and air requirements
    3. Describe how vertical machines function
  C. Describe Nomenclature Used in Vertical Machining
    1. Describe common tools used to:
      a. Mill
      b. Single point thread
      c. Drill
      d. Single point bore
      e. Tap
      f. Reaming
    2. Describe solid and collet type tool holders
  D. Demonstrate Safety Practices Related to Vertical Machining Centers
    1. Demonstrate operating safety practices, including:
      a. Safety door interlocks
      b. Machining vise loading and unloading

        - c. Power box interlocks
        - d. Machine coolant disposal
        - e. Tool loading and unloading
    - 2. Describe/identify personal safety equipment

- II. Describe Vertical Machining Functions
  - A. Describe Controller Functions, including:
    - 1. Power meter
    - 2. Automatic mode
    - 3. Key lock
    - 4. Emergency stop button
    - 5. Option switches
    - 6. Manual modes:
      - a. Command mode
      - b. MDI mode
    - 7. Rapid travel over ride
    - 8. Single step mode (Block-To-Block)
    - 9. Feed rate override
    - 10. Jog mode
    - 11. Spindle speed override
    - 12. Spindle On/Off
    - 13. Axis selector
    - 14. Slide hold
    - 15. Increment of movement selector
    - 16. Coolant 1 and 2 On/Off
    - 17. Tool In/Out
    - 18. Start button
    - 19. Turret clockwise (CW) and turret counterclockwise (CCW)
    - 20. Start function
- III. Set-Up and Program Operation of Vertical Machine
  - A. Describe machine tool limitations, including:
    - 1. Number of possible tools
    - 2. Limits in X,Y and Z axes
    - 3. Maximum spindle speed and horsepower
    - 4. Memory size in controller
    - 5. Fast feed rate
    - 6. Oil and air requirements
    - 7. Rapid positioning rate
    - 8. Communication systems
  - B. Perform basic machine set-up
    - 1. Check oil and air supply
    - 2. Set tool changer numbers
    - 3. Turn power on
    - 4. Mount machine vise on machine table
    - 5. Set machine home position
    - 6. Indicate vise to within specified tolerances

        7. Load tools into proper tool holders
        8. Load part into vise
        9. Load tools into tool carousel
            a. Load tools using spindle
            b. Load tools directly into carousel
    C. Set part home
        1. Set part home using edge finder
        2. Set part home using test indicator and gauge block
        3. Set part home from tooling ball using fixture offsets
    D. Set tool length offsets
        1. Set tool length offsets using work piece
        2. Set tool length offsets using gauge block
        3. Set tool length offsets using electronic probe
        4. Set tool length offsets using keyboard commands
        5. Modify length and diameter offsets using tool page editor.
        6. Upload and download tool information to storage
    E. Load program
        1. Upload and download programs using RS-232 interface
        2. Upload and download programs using local area network
    F. Edit program for machine tool
        1. Edit program at machine tool using editor in controller
        2. Edit program using DOS and Windows editors
    G. Create program without CAD/CAM for common machine operations using machine controllers software to include:
        1. Proper use of cutter compensation
        2. Fixed cycles
        3. Fixed sub-routines
        4. Sub-routines (loops)
        5. Fixture offsets
        6. Trouble shoot and repair problems in programs
        7. Use machine verification options if available

IV. Demonstrate Machining of Objects on Vertical Machining Center
    A. Machine objects, including:
        1. Outside contours
        2. Pockets
        3. Drilled holes
        4. Drill and tapped holes
            a. Rigid tapping
            b. Compression tapping
        5. Single point boring
        6. Reaming
        7. Single point thread, internal and external
    B. Set-up three dimensional digitizer and machine model
        1. Mount model on machine table
        2. Install 3-dimensional digitizing unit

    3. Establish communications with computer
    4. Define grid pattern and feed rate required for given tolerances
    5. Set part home
    6. Digitize model
    7. Process digital data for machining
    8. Machine new model with program created from digitizer
C. Create work piece using 4th- and 5th-axes
    1. Mount, connect and indicate 4th- and 5th-axes attachment
    2. Set-tooling
    3. Machine work piece
    4. Remove 4th- and 5th-axes attachment
D. Maintain vertical machine
    1. Mix coolant
    2. Determine need for coolant change
    3. Change coolant
    4. Clean coolant tank
    5. Clean machine
    6. Change oil filters
    7. Add lubricating fluid
    8. Add hydraulic fluid
    9. Dispose of coolant and oils per EPA regulations

Practical Application:

In our program we have found it very important to require the students to do all aspects of vertical machining. It should be obvious that if an individual cannot set up a machine, then he will be limited to just "pushing buttons."

We have developed this module for not only a specific group of individuals but also many different types of machines/controllers as well as local manufacturer requirements.

Most of the sections of this module are generic to all vertical machines as well as most machine controllers. Please note that there can be a great variation from one machine type to another; this becomes very evident in many of the sections covered in this module.

It is very important that the instructor design projects that are progressive in the level of required sophistication, so that the students will be reinforced as to their ability to complete these requirements.

Evaluation and/or Verification:

As with the Practical Application section above it will be necessary for you to design an evaluation instrument that best suits the environment in which you are presenting this information.

It is important to remember that the subject mastery is represented in the ability to not only perform the application of the technology, but also the ability to explain the process in both oral and written format.

Summary:

Review the main lesson points and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-H3) dealing with programming and operating CNC lathe.

TLD-H2-HO
Program and Operate CNC Milling Machine and Machining Center
Attachment 1: MASTER Handout

Objectives:

Upon completion of this module the student will be able to:

a. Describe history of vertical machining;
b. Describe theory of operation;
c. Describe nomenclature used in vertical machining;
d. Demonstrate safety practices related to vertical machining centers;
e. Set-up and program operation of vertical machine;
f. Demonstrate proper machining of objects;
g. Create program using machine controllers software, and cycles;
h. Set-up and utilize three dimensional digitizer; and,
i. Maintain vertical machine.

Module Outline:

I. Describe Vertical Machining Process and Safety
  A. Describe History of Vertical Machining
    1. Describe proper use of various machines
  B. Describe Theory of Operation
    1. Describe open and closed loop systems
    2. Describe various oil and air requirements
    3. Describe how vertical machines function
  C. Describe Nomenclature Used in Vertical Machining
    1. Describe common tools used to:
      a. Mill
      b. Single point thread
      c. Drill
      d. Single point bore
      e. Tap
      f. Reaming
    2. Describe solid and collet type tool holders
  D. Demonstrate Safety Practices Related to Vertical Machining Centers
    1. Demonstrate operating safety practices, including:
      a. Safety door interlocks
      b. Machining vise loading and unloading
      c. Power box interlocks
      d. Machine coolant disposal
      e. Tool loading and unloading
    2. Describe/identify personal safety equipment

II. Describe Vertical Machining Functions

A. Describe Controller Functions, including:
  1. Power meter
  2. Automatic mode
  3. Key lock
  4. Emergency stop button
  5. Option switches
  6. Manual modes:
     a. Command mode
     b. MDI mode
  7. Rapid travel over ride
  8. Single step mode (Block-To-Block)
  9. Feed rate override
  10. Jog mode
  11. Spindle speed override
  12. Spindle On/Off
  13. Axis selector
  14. Slide hold
  15. Increment of movement selector
  16. Coolant 1 and 2 On/Off
  17. Tool In/Out
  18. Start button
  19. Turret clockwise (CW) and turret counterclockwise (CCW)
  20. Start function

III. Set-Up and Program Operation of Vertical Machine
  A. Describe machine tool limitations, including:
    1. Number of possible tools
    2. Limits in X,Y and Z axes
    3. Maximum spindle speed and horsepower
    4. Memory size in controller
    5. Fast feed rate
    6. Oil and air requirements
    7. Rapid positioning rate
    8. Communication systems
  B. Perform basic machine set-up
    1. Check oil and air supply
    2. Set tool changer numbers
    3. Turn power on
    4. Mount machine vise on machine table
    5. Set machine home position
    6. Indicate vise to within specified tolerances
    7. Load tools into proper tool holders
    8. Load part into vise
    9. Load tools into tool carousel
       a. Load tools using spindle
       b. Load tools directly into carousel

C. Set part home
  1. Set part home using edge finder
  2. Set part home using test indicator and gauge block
  3. Set part home from tooling ball using fixture offsets

D. Set tool length offsets
  1. Set tool length offsets using work piece
  2. Set tool length offsets using gauge block
  3. Set tool length offsets using electronic probe
  4. Set tool length offsets using keyboard commands
  5. Modify length and diameter offsets using tool page editor.
  6. Upload and download tool information to storage

E. Load program
  1. Upload and download programs using RS-232 interface
  2. Upload and download programs using local area network

F. Edit program for machine tool
  1. Edit program at machine tool using editor in controller
  2. Edit program using DOS and Windows editors

G. Create program without CAD/CAM for common machine operations using machine controllers software to include:
  1. Proper use of cutter compensation
  2. Fixed cycles
  3. Fixed sub-routines
  4. Sub-routines (loops)
  5. Fixture offsets
  6. Trouble shoot and repair problems in programs
  7. Use machine verification options if available

IV. Demonstrate Machining of Objects on Vertical Machining Center

A. Machine objects, including:
  1. Outside contours
  2. Pockets
  3. Drilled holes
  4. Drill and tapped holes
    a. Rigid tapping
    b. Compression tapping
  5. Single point boring
  6. Reaming
  7. Single point thread, internal and external

B. Set-up three dimensional digitizer and machine model
  1. Mount model on machine table
  2. Install 3-dimensional digitizing unit
  3. Establish communications with computer
  4. Define grid pattern and feed rate required for given tolerances
  5. Set part home
  6. Digitize model
  7. Process digital data for machining

    8. Machine new model with program created from digitizer

C. Create work piece using 4th- and 5th-axes
    1. Mount, connect and indicate 4th- and 5th-axes attachment
    2. Set-tooling
    3. Machine work piece
    4. Remove 4th- and 5th-axes attachment

D. Maintain vertical machine
    1. Mix coolant
    2. Determine need for coolant change
    3. Change coolant
    4. Clean coolant tank
    5. Clean machine
    6. Change oil filters
    7. Add lubricating fluid
    8. Add hydraulic fluid
    9. Dispose of coolant and oils per EPA regulations

TLD-H2-LE/SA
Program and Operate CNC Milling Machine and Machining Center
Attachment 2: MASTER Laboratory Exercise/Self-Assessment

Note to the Instructor:

Because of the wide variety of CNC machining centers and CNC mills available, student laboratory and assessment activities must be developed by the instructor for his or her particular laboratory equipment. All laboratory exercises and student assessments should be "hands on" which stress machine safety and assess the student's mastery of each of the lesson objectives.

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and,
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

TLD-H3

TOOL & DIE and EDM SERIES

MASTER Technical Module No. TLD-H3

Subject: **Tool & Die and EDM** **Time: 50 Hrs.**

Duty: **Perform CAD/CAM and CNC Programming Tasks**
Task: Program and Operate CNC Lathe

Objectives:

Upon completion of this module the student will be able to:

a. Describe history of horizontal turning centers;
b. Describe theory of operation;
c. Describe nomenclature used in horizontal turning centers;
d. Demonstrate safety practices related to horizontal turning centers;
e. Set-up and program operation of horizontal turning centers;
f. Demonstrate proper machining of objects;
g. Create program using machine controllers software; and,
h. Maintain horizontal turning centers.

Instructional Materials:

MASTER Handout (TLD-H3-HO)
MASTER Laboratory Exercise/Self Assessment (TLD-H3-LE/SA)
MASTER Laboratory Aid (TLD-H3-LA)

References:

Computer Numerical Control, From Programming to Networking, S.C. Jonathan Lin, Delmar Publishers Inc., Latest Edition
Programming Manual for your CNC Machine, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:

TLD-H1 "Discuss Fundamentals of CNC Machines and Controls"
TLD-H2 "Program and Operate CNC Milling Machine and Machining Center"

Introduction:

With the introduction of the first NC machines, machining was changed forever. In the beginning, ownership of NC machines was limited to those companies that possessed great financial resources. The need for these machines, even if one had the capital, was limited to those companies that produced long production runs that required little (if any) design variation. These early machines were not user friendly nor were they quick to program, set up or operate. The advent of modern computers along with major changes in associated electronics has changed this scenario forever. Today the vast majority of companies have at least one CNC machine if not many. Most of the new employment is offered in the use and programming of these machines. It is no longer an option as to whether a technician wants to learn how to use a CNC machining center. The overall popularity of CNC machines is increasing dramatically and this trend demands that all technicians accept CNC as they have any other tool of their trade.

This module addresses the application of the CNC turning center, which is really just a hybrid of the common lathe, its conventional counterpart with the addition of many of its attachments.

This module can be used for individuals who will be using turning centers at various levels from CNC operator to CNC technicians. The ability to complete these tasks both quickly and accurately in various settings will, in most cases, be one of the deciding factors of how long an individual will stay at the operator level or progress into the programming area.

Presentation Outline:

I. Explain CNC Turning Process, Equipment and Safety
    A. Describe CNC turning process
        1. Describe history of CNC turning
        2. Describe use of various turning machines
    B. Describe theory of operation
        1. Describe open and closed loop systems
        2. Describe various oil and air requirements
        3. Describe how turning centers function
    C. Describe nomenclature used in CNC turning
        1. Describe and identify common tools used to:
            a. Turn
            b. Drill
            c. Groove
            d. Face
            e. Bore
            f. Single point thread

- g. Tap
- 2. Describe and identify work holding devices used in turning, including:
  - a. 2-jaw chucks
  - b. 3-jaw chuck
  - c. 4-jaw chucks
  - d. Soft jaw chucks
  - e. Bar feed attachments
  - f. Collets
  - g. Centers
- 3. Select proper cutting inserts relative to:
  - a. Roughing
  - b. Finishing
  - c. Threading
  - d. Different types of materials

- D. Demonstrate safety practices related to CNC turning centers
  - 1. Demonstrate operating safety practices, including:
    - a. Safety door interlocks
    - b. Power box interlocks
    - c. Tool loading and unloading
    - d. Loading and unloading work holding devices
    - e. Machine coolant disposal
  - 2. Describe/identify personal safety equipment

- II. Describe CNC Turning Center
  - A. Describe controller functions, including:
    - 1. Power meter
    - 2. Option switches
    - 3. Key lock
    - 4. Emergency stop button
    - 5. Rapid travel override
    - 6. Feed rate override
    - 7. Spindle speed override
    - 8. Axis selector
    - 9. Increment of movement selector
    - 10. Slide hold
    - 11. Start function
  - B. Describe keyboard functions, including:
    - 1. Automatic mode
    - 2. Manual MDI mode
    - 3. Single step mode (block-to-block)
    - 4. Jog mode
    - 5. Spindle on/off
    - 6. Coolant on/off
    - 7. Tool turret clockwise (CW) and tool turret counterclockwise (CCW)

- III. Set-Up and Program Operation of CNC Turning Center
  - A. Describe machine tool limitations, including:
    - 1. Number of possible tools
    - 2. Maximum spindle speed and horsepower
    - 3. Fast feed rate
    - 4. Rapid positioning rate
    - 5. Limits in X and Z axes
    - 6. Memory size in controller
    - 7. Oil and air requirements
    - 8. Communication systems
  - B. Perform basic machine set-up
    - 1. Check oil and air supply
    - 2. Turn power on
    - 3. Set machine home position
    - 4. Load tools into proper tool holders
    - 5. Load tools into tool carousel
    - 6. Set tool changer numbers
    - 7. Mount work piece into chuck
    - 8. Indicate work piece within specified tolerances
  - C. Set tool length offsets
    - 1. Set tool length offsets using work piece
    - 2. Set tool length offsets using keyboard commands
    - 3. Modify length and diameter offsets using tool page editor
    - 4. Modify length and diameter offsets using keyboard
    - 5. Upload and download tool information to storage
  - D. Load program
    - 1. Upload and download programs using RS-232 interface
    - 2. Upload and download programs using local area network
  - E. Edit program for machine tool
    - 1. Edit program at machine tool using editor in controller
    - 2. Edit program using DOS and Windows editors
- IV. Create Program Without CAD/CAM for Common Machine Operations Using Machine Controllers Software to include:
  - A. Proper use of cutter compensation
  - B. Fixed cycles
  - C. Fixed sub-routines
  - D. Sub-routines (loops)
  - E. Fixture offsets
  - F. Trouble shoot and repair problems in programs
  - G. Use machine verification options if available
- V. Create Program for Common Machine Operations
  - A. Use machine controller editor
  - B. Use DOS editor
  - C. Use Windows editor
- VI. Demonstrate Machining of Objects on CNC Turning Center

- A. Machine objects, including:
  1. External and internal contouring
  2. External and internal grooving
  3. Drill and tapped holes
  4. Single point boring
  5. Reaming
  6. Single point thread internal and external
  7. Facing operations
  8. Turning tapers
- B. Maintain turning center
  1. Mix coolant
  2. Determine need for coolant change
  3. Change coolant
  4. Clean coolant tank
  5. Clean machine
  6. Change oil filters
  7. Add lubricating fluid
  8. Add hydraulic fluid
  9. Dispose of coolant and oils per EPA regulations

Practical Application:

In our program we have found it very important to require the students to do all aspects of vertical machining. It should be obvious that if an individual cannot set up a machine, then he will be limited to just "pushing buttons."

We have developed this module for not only a specific group of individuals but also many different types of machines/controllers as well as local manufacturer requirements.

Most of the sections of this module are generic to all vertical machines as well as most machine controllers. Please note that there can be a great variation from one machine type to another; this becomes very evident in many of the sections covered in this module.

It is very important that the instructor design projects that are progressive in the level of required sophistication, so that the students will be reinforced as to their ability to complete these requirements.

Evaluation and/or Verification:

As with the Practical Application section above it will be necessary for you to design an evaluation instrument that best suits the environment in which you are presenting this information.

It is important to remember that the subject mastery is represented in the ability to not only perform the application of the technology, but also the ability to explain the process in both oral and written format.

Summary:

Review the main lesson points and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-H4) dealing with using Computer-Aided Drafting (CAD) system.

TLD-H3-HO
Program and Operate CNC Lathe
Attachment 1: MASTER Handout

Objectives:

Upon completion of this module the student will be able to:

a. Describe history of horizontal turning centers;
b. Describe theory of operation;
c. Describe nomenclature used in horizontal turning centers;
d. Demonstrate safety practices related to horizontal turning centers;
e. Set-up and program operation of horizontal turning centers;
f. Demonstrate proper machining of objects;
g. Create program using machine controllers software; and,
h. Maintain horizontal turning centers.

Module Outline:

I. Explain CNC Turning Process, Equipment and Safety
  A. Describe CNC turning process
    1. Describe history of CNC turning
    2. Describe use of various turning machines
  B. Describe theory of operation
    1. Describe open and closed loop systems
    2. Describe various oil and air requirements
    3. Describe how turning centers function
  C. Describe nomenclature used in CNC turning
    1. Describe and identify common tools used to:
      a. Turn
      b. Drill
      c. Groove
      d. Face
      e. Bore
      f. Single point thread
      g. Tap
    2. Describe and identify work holding devices used in turning, including:
      a. 2-jaw chucks
      b. 3-jaw chuck
      c. 4-jaw chucks
      d. Soft jaw chucks
      e. Bar feed attachments
      f. Collets
      g. Centers

        3. Select proper cutting inserts relative to:
            a. Roughing
            b. Finishing
            c. Threading
            d. Different types of materials
    D. Demonstrate safety practices related to CNC turning centers
        1. Demonstrate operating safety practices, including:
            a. Safety door interlocks
            b. Power box interlocks
            c. Tool loading and unloading
            d. Loading and unloading work holding devices
            e. Machine coolant disposal
        2. Describe/identify personal safety equipment

II. Describe CNC Turning Center
    A. Describe controller functions, including:
        1. Power meter
        2. Option switches
        3. Key lock
        4. Emergency stop button
        5. Rapid travel override
        6. Feed rate override
        7. Spindle speed override
        8. Axis selector
        9. Increment of movement selector
        10. Slide hold
        11. Start function
    B. Describe keyboard functions, including:
        1. Automatic mode
        2. Manual MDI mode
        3. Single step mode (block-to-block)
        4. Jog mode
        5. Spindle on/off
        6. Coolant on/off
        7. Tool turret clockwise (CW) and tool turret counterclockwise (CCW)

III. Set-Up and Program Operation of CNC Turning Center
    A. Describe machine tool limitations, including:
        1. Number of possible tools
        2. Maximum spindle speed and horsepower
        3. Fast feed rate
        4. Rapid positioning rate
        5. Limits in X and Z axes
        6. Memory size in controller
        7. Oil and air requirements
        8. Communication systems

B. Perform basic machine set-up
   1. Check oil and air supply
   2. Turn power on
   3. Set machine home position
   4. Load tools into proper tool holders
   5. Load tools into tool carousel
   6. Set tool changer numbers
   7. Mount work piece into chuck
   8. Indicate work piece within specified tolerances

C. Set tool length offsets
   1. Set tool length offsets using work piece
   2. Set tool length offsets using keyboard commands
   3. Modify length and diameter offsets using tool page editor
   4. Modify length and diameter offsets using keyboard
   5. Upload and download tool information to storage

D. Load program
   1. Upload and download programs using RS-232 interface
   2. Upload and download programs using local area network

E. Edit program for machine tool
   1. Edit program at machine tool using editor in controller
   2. Edit program using DOS and Windows editors

IV. Create Program Without CAD/CAM for Common Machine Operations Using Machine Controllers Software to include:

A. Proper use of cutter compensation
B. Fixed cycles
C. Fixed sub-routines
D. Sub-routines (loops)
E. Fixture offsets
F. Trouble shoot and repair problems in programs
G. Use machine verification options if available

V. Create Program for Common Machine Operations

A. Use machine controller editor
B. Use DOS editor
C. Use Windows editor

VI. Demonstrate Machining of Objects on CNC Turning Center

A. Machine objects, including:
   1. External and internal contouring
   2. External and internal grooving
   3. Drill and tapped holes
   4. Single point boring
   5. Reaming
   6. Single point thread internal and external
   7. Facing operations
   8. Turning tapers

B. Maintain turning center

1. Mix coolant
2. Determine need for coolant change
3. Change coolant
4. Clean coolant tank
5. Clean machine
6. Change oil filters
7. Add lubricating fluid
8. Add hydraulic fluid
9. Dispose of coolant and oils per EPA regulations

TLD-H3-LE/SA
Program and Operate CNC Lathe
Attachment 2: MASTER Laboratory Exercise/Self-Assessment

Note to the Instructor:

Because of the wide variety of CNC machining centers and CNC mills available, student laboratory and assessment activities must be developed by the instructor for his or her particular laboratory equipment. All laboratory exercises and student assessments should be "hands on" which stress machine safety and assess the student's mastery of each of the lesson objectives.

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

TLD-H4

TOOL & DIE and EDM SERIES

MASTER Technical Module No. TLD-H4

Subject: Tool & Die and EDM **Time:** 40 Hrs.

Duty: **Perform CAD/CAM and CNC Programming Tasks**
Task: Use Computer-Aided Drafting (CAD) System

Objective(s):

Upon completion of this unit the student will be able to:
a. Create geometry using CAD system;
b. Create 3-D solid models;
c. Interconvert CAD and accepted drawing exchange formats;
d. Configure CAD system parameters; and,
e. Use peripheral devices.

Instructional Materials:

MASTER Handout (TLD-H4-HO)
MASTER Self-Assessment

References:

AutoCAD Release 12 & 13 Reference Manual, Autodesk, Inc., Latest Edition

Harnessing AutoCAD Release 12 & 13 for DOS and Windows, Thomas A. Stellman, G.V. Krishnan and Robert A. Rhea, Delmar Publishing Co., Latest Editions

Autocad: A Problem Solving Approach, Sham Tickoo, Autodesk (registered author), Delmar Publishing Co., Latest Edition

AutoCAD for Success Release 13, Stephen U. Ethier and Christine A. Ethier, Prentice-Hall, Inc., Latest Edition

AutoCAD and Its Applications Basics, Release 13 DOS, Terence M. Shumaker and David A. Madsen, Goodheart-Wilcox Co. Inc., Latest Edition

The AutoCAD Book: Drawing, Modeling, and Applications Release 12, James M. Kirkpatrick, Merrill, MacMillan Publishing Co., Latest Edition

The AutoCAD Tutor: For Engineering Graphics Release 12 & 13, Alan J. Kalameja, Delmar Publishing Inc., Latest Edition

The AutoCAD Book: Drawing, Modeling, and Applications Including Release 13, James M. Kirkpatrick, Pentice-Hall, Inc., Latest Edition

AutoCAD in 3 Dimension Windows Version**, Stephen J. Ethier and Christine A. Ethier, Prentice-Hall, Inc., Latest Edition**

Student Preparation:

Students should have previously completed the following Technical Modules:

TLD-B1 through TLD-B5	"Apply Mathematical Concepts"
TLD-C1	"Interpret and Understand Basic Layout/Types of Drawings"
TLD-C2	"Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances"
TLD-C3	"Use and Apply Geometric Dimensioning and Tolerancing (GD&T)"
TLD-C4	"Demonstrate Traditional Mechanical Drafting and Sketching Techniques"
TLD-G1 through TLD-G4	"Use Computers"

Introduction:

Computer-Aided Drafting (CAD) is just a tool to be used by any operator from senior designer to any and every employee. It can be used to perform tasks in the engineering design office, or in the manufacturing process, actual production and delivery of a product. This tool can be used by the tool and die maker to design, check, and produce programs, 2D and 3D, geometry, and actual products. This tool can be readily connected to almost any machine in the shop to complete almost any type of shop process of procedure.

Presentation Outline:

I. Identify System Requirements
  A. Hardware present and available
  B. Software present and available
  C. Equipment currently available
    1. Monitors
    2. CPU
    3. Keyboards
    4. Mouse
  D. Peripheral devices available
    1. Printer
    2. Plotters
    3. LCD
    4. Digitizer

II. Access and Maneuver Within CAD System
  A. Use basic DOS commands
    1. Copy

    2. Move
    3. Delete
    4. List files
    5. Make directory
    6. Change directory
    7. Root directory
  B. Initiate graphics editor
    1. Open existing files
    2. Creating new files
    3. Save/Save As files
    4. Q Saves files
    5. Quitting a graphic session
    6. Ending a graphic session
  C. Use various disk drives
  D. Use command line
  E. Use graphics area
  F. Use graphics cursor
  G. Use screen menus and submenus
  H. Use status and coordinate display line
  I. Use pull-down menus
  J. Use cursor menu
  K. Use keyboard
    1. Control keys
    2. Function keys
    3. Special keys
    4. Arrow keys
    5. Numeric value keys

III. Create Geometry Using CAD System
  A. Use utility and services commands
    1. Help
    2. New
    3. Open
    4. Save
    5. Exit
    6. Config
    7. About
    8. Status
    9. Limits
    10. Units
    11. Tablet
    12. Reinit
    13. Menu
    14. Compile
    15. Files
    16. Audit

17. Recover
18. Multiple
19. Time
20. Setvar

B. Use the entity draw commands
   1. Line
   2. Point
   3. Circle
   4. Arc
   5. Trace
   6. Pline
   7. Polygon
   8. Doughnut
   9. Ellipse
   10. Sketch
   11. Solid
   12. Text
   13. D text
   14. Style

C. Use the edit and inquiry commands
   1. Grips
   2. Erase
   3. Copy
   4. Move
   5. Rotate
   6. Scale
   7. Mirror
   8. Stretch
   9. Array
   10. Change
   11. Pdedit
   12. Break
   13. Trim
   14. Extend
   15. Fillet
   16. Chamfer
   17. Offset
   18. Divide
   19. Measure
   20. Pedit
   21. Explode
   22. U/undo
   23. Redo
   24. List
   25. Dblist

26. 10
27. Dist
28. Area

D. Use the display control commands
   1. Model space
   2. Paper space
   3. Viewports
   4. Regeneration
   5. Redraw
   6. Zoom
   7. Pan
   8. View
   9. Mview
   10. Redraw all
   11. Regen all
   12. Fill Qtext
   13. RegenAuto
   14. Dragmode
   15. Blipmode
   16. Viewers

E. Use the entity properties commands
   1. Layer
   2. DDLmodes
   3. DDEmodes
   4. Color
   5. Linetype
   6. LtScale

F. Use the drawing aids commands
   1. DDRmodes
   2. Snap
   3. Grid
   4. Ortho
   5. UCS
   6. DDUCS
   7. Ulsicon
   8. Object snap
   9. DDOsnap
   10. Osnap
   11. Aperture

G. Use the blocks and attributes commands
   1. Block
   2. DDinsert
   3. Insert
   4. Minsert
   5. Wblock

   6. Attributes
   7. DDATTDEF
   8. ATTDEF
   9. ATTDISP
   10. ATTEDIT
   11. DDATTE
   12. DDATTEXT
   13. ATTEXT
 H. Use the cross-section and pattern filling commands
   1. BHATCH
   2. HATCH
   3. BPOLY
   4. Hatching system variables
IV. Dimensioning Geometry Using CAD System
 A. DIM and DIM I
 B. Associative dimensioning
   1. Terms
   2. Variables
   3. Styles
   4. Points
   5. Model/Paper space
 C. Dimension styles
   1. Override
   2. Restore
   3. Save
   4. Variables
   5. Stylenames
 D. Dimension variables
   1. Style
   2. Scaling
   3. Color
   4. Dimension line
   5. Extension line
   6. Arrows
   7. Text location
   8. Text format
   9. Features
   10. Colors
 E. Dimensioning geometry commands
   1. Linear
   2. Angular
   3. Diameter
   4. Radius
   5. Center marks and lines
   6. Ordinate

- F. Dimension editing
    - 1. Home text
    - 2. New text
    - 3. Oblique
    - 4. TEDIT
    - 5. Trotate
    - 6. Update
- G. Dimension utility
    - 1. Exit
    - 2. Leader
    - 3. Redraw
    - 4. Status
    - 5. Styles
    - 6. Undo

V. Use Peripheral Devices

- A. Printers
- B. Plotters
    - 1. CMDDIM system variable
    - 2. Plot
        - a. Devices and defaults
        - b. Pen parameters
        - c. Additional parameters
        - d. Paper size and orientation
        - e. Scale
        - f. Rotation
        - g. Origin
        - h. Plot preview
- C. Liquid crystal displays
- D. Overhead projectors
- E. Digitizer tablets

VI. Interconvert CAD and Accepted Drawing Exchange Formats

- A. Post Script Support
    - 1. PSOUT
    - 2. PSIN
    - 3. PSFILL
- B. Slide shows
    - 1. MSLIDE
    - 2. VSLIDE
    - 3. Filmroll
- C. Drawing interchange file (ASCII or Binary)
    - 1. DXFIIN
    - 2. DXFOUT
    - 3. DXBIN
- D. Initial graphic exchange specification
    - 1. IGESIN

2. IGESOUT

Practical Application:

Students should be given several drawings of various types with varying degrees of complexity to read and answer questions about.

Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this lesson, along with successful completion of blueprint reading exercises.

Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-H5) dealing with creating 3-D solid models.

TLD-H4-HO
Use Computer-Aided Drafting (CAD) System
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Create geometry using CAD system;
b. Create 3-D solid models;
c. Interconvert CAD and accepted drawing exchange formats;
d. Configure CAD system parameters; and,
e. Use peripheral devices.

Module Outline:

I. Identify System Requirements
  A. Hardware present and available
  B. Software present and available
  C. Equipment currently available
    1. Monitors
    2. CPU
    3. Keyboards
    4. Mouse
  D. Peripheral devices available
    1. Printer
    2. Plotters
    3. LCD
    4. Digitizer
II. Access and Maneuver Within CAD System
  A. Use basic DOS commands
    1. Copy
    2. Move
    3. Delete
    4. List files
    5. Make directory
    6. Change directory
    7. Root directory
  B. Initiate graphics editor
    1. Open existing files
    2. Creating new files
    3. Save/Save As files
    4. Q Saves files
    5. Quitting a graphic session
    6. Ending a graphic session

- C. Use various disk drives
- D. Use command line
- E. Use graphics area
- F. Use graphics cursor
- G. Use screen menus and submenus
- H. Use status and coordinate display line
- I. Use pull-down menus
- J. Use cursor menu
- K. Use keyboard
  1. Control keys
  2. Function keys
  3. Special keys
  4. Arrow keys
  5. Numeric value keys

III. Create Geometry Using CAD System

- A. Use utility and services commands
  1. Help
  2. New
  3. Open
  4. Save
  5. Exit
  6. Config
  7. About
  8. Status
  9. Limits
  10. Units
  11. Tablet
  12. Reinit
  13. Menu
  14. Compile
  15. Files
  16. Audit
  17. Recover
  18. Multiple
  19. Time
  20. Setvar
- B. Use the entity draw commands
  1. Line
  2. Point
  3. Circle
  4. Arc
  5. Trace
  6. Pline
  7. Polygon
  8. Doughnut

    9. Ellipse
    10. Sketch
    11. Solid
    12. Text
    13. D text
    14. Style

C. Use the edit and inquiry commands

    1. Grips
    2. Erase
    3. Copy
    4. Move
    5. Rotate
    6. Scale
    7. Mirror
    8. Stretch
    9. Array
    10. Change
    11. Pdedit
    12. Break
    13. Trim
    14. Extend
    15. Fillet
    16. Chamfer
    17. Offset
    18. Divide
    19. Measure
    20. Pedit
    21. Explode
    22. U/undo
    23. Redo
    24. List
    25. Dblist
    26. 10
    27. Dist
    28. Area

D. Use the display control commands

    1. Model space
    2. Paper space
    3. Viewports
    4. Regeneration
    5. Redraw
    6. Zoom
    7. Pan
    8. View
    9. Mview

10. Redraw all
11. Regen all
12. Fill Qtext
13. RegenAuto
14. Dragmode
15. Blipmode
16. Viewers

E. Use the entity properties commands
   1. Layer
   2. DDLmodes
   3. DDEmodes
   4. Color
   5. Linetype
   6. LtScale

F. Use the drawing aids commands
   1. DDRmodes
   2. Snap
   3. Grid
   4. Ortho
   5. UCS
   6. DDUCS
   7. Ulsicon
   8. Object snap
   9. DDOsnap
   10. Osnap
   11. Aperture

G. Use the blocks and attributes commands
   1. Block
   2. DDinsert
   3. Insert
   4. Minsert
   5. Wblock
   6. Attributes
   7. DDATTDEF
   8. ATTDEF
   9. ATTDISP
   10. ATTEDIT
   11. DDATTE
   12. DDATTEXT
   13. ATTEXT

H. Use the cross-section and pattern filling commands
   1. BHATCH
   2. HATCH
   3. BPOLY
   4. Hatching system variables

IV. Dimensioning Geometry Using CAD System
   A. DIM and DIM I
   B. Associative dimensioning
      1. Terms
      2. Variables
      3. Styles
      4. Points
      5. Model/Paper space
   C. Dimension styles
      1. Override
      2. Restore
      3. Save
      4. Variables
      5. Stylenames
   D. Dimension variables
      1. Style
      2. Scaling
      3. Color
      4. Dimension line
      5. Extension line
      6. Arrows
      7. Text location
      8. Text format
      9. Features
      10. Colors
   E. Dimensioning geometry commands
      1. Linear
      2. Angular
      3. Diameter
      4. Radius
      5. Center marks and lines
      6. Ordinate
   F. Dimension editing
      1. Home text
      2. New text
      3. Oblique
      4. TEDIT
      5. Trotate
      6. Update
   G. Dimension utility
      1. Exit
      2. Leader
      3. Redraw
      4. Status
      5. Styles

    6. Undo
V. Use Peripheral Devices
  A. Printers
  B. Plotters
    1. CMDDIM system variable
    2. Plot
      a. Devices and defaults
      b. Pen parameters
      c. Additional parameters
      d. Paper size and orientation
      e. Scale
      f. Rotation
      g. Origin
      h. Plot preview
  C. Liquid crystal displays
  D. Overhead projectors
  E. Digitizer tablets
VI. Interconvert CAD and Accepted Drawing Exchange Formats
  A. Post Script Support
    1. PSOUT
    2. PSIN
    3. PSFILL
  B. Slide shows
    1. MSLIDE
    2. VSLIDE
    3. Filmroll
  C. Drawing interchange file (ASCII or Binary)
    1. DXFIIN
    2. DXFOUT
    3. DXBIN
  D. Initial graphic exchange specification
    1. IGESIN
    2. IGESOUT

Name____________________________ Date________________

TLD-H4
Use Computer-Aided Drafting (CAD) System
Self-Assessment

1. Identify present and available software.

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2. Identify present and available hardware.

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3. Name three pieces of equipment currently available and describe their various uses.

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4. Name and describe three peripheral devices.

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____

5. Name and define five basic DOS commands used in a CAD system.

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____

____

6. Identify and describe four graphic editor commands used in a CAD system.

____

____

____

7. What is a disk drive?

____

____

____

8. What is a command line?

9. Describe the graphics area.

10. Define screen menus and submenus.

11. Identify and describe status and coordinate display line.

12. Describe a pull-down menu.

13. What is a cursor menu?

14. List and define four types of keys used on a keyboard.

15. Name and define four utility commands used in a CAD system.

16. Name and describe four service commands used in a CAD system.

17. Identify and define five entity draw commands used in a CAD system.

18. What are inquiry commands?

19. Name and define three inquiry commands used in a CAD system.

20. What are edit commands?

21. Name and describe four edit commands used in a CAD system.

22. What are display commands?

23. Name and define five display control commands used in a CAD system.

24. What are entity properties commands?

25. List and describe three entity properties commands used in a CAD system.

26. What are drawing aid commands?

27. Identify and define four drawing aid commands used in a CAD system.

28. What are block commands?

29. List and describe two block commands used in a CAD system.

30. What are attributes commands?

31. Name and define three attribute commands used in a CAD system.

32. What is cross-section and pattern filling commands?

33. Name and describe three associative dimensioning commands used in a CAD system.

34. Identify and define three dimension styles commands used in a CAD system.

35. Name and describe three dimension variable commands used in a CAD system.

36. Identify and define three dimension drawing commands used in a CAD system.

37. List and describe three dimension editing commands used in a CAD system.

38. Name and define three dimension utility commands used in a CAD system.

39. Identify and describe 4 plot parameters that must be set prior to plotting using a CAD system.

40. Name and define three types of peripheral devices that could be used with a CAD system.

41. List and describe three types of postscript support which could be used with a CAD system.

42. What do slide show presentations consist of in use with a CAD system?

43. **Name and describe three drawing interchange files that could be used with a CAD system.**

44. **Identify and define two initial graphic exchange specifications that could be used with a CAD system.**

TLD-H5

TOOL & DIE and EDM SERIES

MASTER Technical Module No. TLD-H5

Subject: **Tool & Die and EDM** **Time: 60 Hrs.**

Duty: **Perform CAD/CAM and CNC Programming Tasks**
Task: Create 3-D Solid Models

Objective(s):

Upon completion of this unit the student will be able to:

a. Access and maneuver within a CAD system;
b. Create 3-D solid geometry models;
c. Dimension 3-D geometry;
d. Display commands to generate prototype borders;
e. Display commands to control drawing representation on the screen;
f. Display commands used to generate and manipulate viewports;
g. Setting commands to assist with 3-D geometry;
h. Layer commands to place entities into specified layer options;
i. Use isometric geometry commands;
j. Use 3-D surface and object commands;
k. Use utility to manage files;
l. Use utility commands to generate slides, script files, and access external commands of the system;
m. Use keyboard to manipulate function keys, special keys, control, and special character keys;
n. Use presentation graphics and rendering commands;
o. Use solid commands to generate 3-D solid model geometry;
p. Use 3-D solid modifiers commands;
q. Use solid 3-D inquiry commands;
r. Use solid 3-D representation commands;
s. Use solid 3-D utility commands;
t. Use LISP programs to generate 3-D solid model geometry;
u. Use Application Programming Interface (API) functions;
v. Use bonus 3-D solid feature commands; and,
w. Use CAD system to digitize paper drawings.

Instructional Materials:

MASTER Handout (TLD-H5-HO)
MASTER Self-Assessment

References:

AutoCAD in 3 Dimensions Windows Version, Stephen U. Ethier and Christine A. Ethier, Prentice-Hall Inc., Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
TLD-H4 "Use Computer-Aided Drafting (CAD) System"

Introduction:

Humans learn primarily from concrete concepts. One must be able to touch an object physically to better understand its purpose or operation. Before three-dimensional geometry generated by computers was ever possible a model maker was employed to make a tangible prototype. A model generated on a computer consists of numerical data that describes the geometry of an object. This is easier and quicker to change than the model maker prototype. Once the model database has been constructed the computer recognizes it has three dimensions. The tool and die maker can then manipulate and massage data to change the object and its display quickly and efficiently, which could not have possibly been done with a physical model.

Presentation Outline:

I. Access and Maneuver Within a CAD System
    A. Use Disk Operating System commands
    B. Use the initial graphics editor within a CAD system
II. Create 3-D Solid Geometry Models
    A. Use the blocks and attributed commands
        1. Block
        2. Insert
        3. DDInsert
        4. MInset
        5. WBlock
        6. 3-DBlock
        7. Attributes
        8. DDATTDEF
        9. ATTDEF
        10. ATTDISP
        11. ATTEDIT
        12. DDATTE
        13. DDATTEXT
        14. ATTEXT
III. Dimension 3-D Geometry

A. Dim and Dim1

B. Associative dimensioning drawing commands
   1. Linear
   2. Angular
   3. Diameter
   4. Radius
   5. Ordinate
   6. Aligned
   7. Baseline
   8. Center
   9. Continue
   10. Vertical
   11. Horizontal
   12. Rotated

C. Dimension style command
   1. Override
   2. Restore
   3. Save
   4. Variable
   5. Style name

D. Dimension editing commands
   1. Hometext
   2. Newtext
   3. Oblique
   4. Tedit
   5. Trotate
   6. Update

E. Dimension utility commands
   1. Exit
   2. Leader
   3. Redraw
   4. Status
   5. Style
   6. Undo

F. Dimension variable commands
   1. DIMALT
   2. DIMALTD
   3. DIMALTF
   4. DIMAPOST
   5. DIMASO
   6. DIMAZ
   7. DIMBLK
   8. DIMCEN
   9. DIMCLRD
   10. DIMCLRE

    11. DIMCLRT
    12. DIMDLE
    13. DIMDLI
    14. DIMEXE
    15. DIMEXO
    16. DIMGAP
    17. DIMLFAC
    18. DIMLIM
    19. DIMPOST
    20. DIMRND
    21. DIMSAH
    22. DIMSCALE
    23. DIMSE1
    24. DIMSE2
    25. DIMSHO
    26. DIMTAD
    27. DIMTFAC
    28. DIMTIH
    29. DIMTIX
    30. DIMTM
    31. DIMTOFL
    32. DIMTOH
    33. DIMTOL
    34. DIMTP
    35. DIMTSZ
    36. DIMTVP
    37. DIMTXT
    38. DIMZIN

IV. Display Commands to Generate Prototype Borders
  A. View
  B. Layout
  C. MVSetup

V. Display Commands to Control Drawing Representation on the Screen
  A. View
  B. DView
  C. DView Slide Bar
  D. Plan
  E. Vpoint
  F. Shade
  G. Zoom
  H. Redraw
  I. Pan
  J. Hide
  K. Viewports
  L. REGEN

- M. REDRAWALL
- N. REGENALL
- O. REGENAUTO
- P. VIEWERS
- Q. FILL

VI. Display Commands Used to Generate and Manipulate Viewports
- A. MView
- B. On
- C. Off
- D. HidePlot
- E. Fit
- F. MView
- G. MSpace
- H. PSpace
- I. TileMode
- J. VPlayer

VII. Setting Commands to Assist With 3-D Geometry
- A. DDEMODES
- B. DDRMODES
- C. APERTURE
- D. AXIS
- E. BLIPS
- F. COLOR
- G. DRAGMODE
- H. ELEVATION
- I. GRID
- J. LINETYPE
- K. LIMITS
- L. LTSCALE
- M. OSNAP
- N. QTEXT
- O. SETVARIABLE
- P. SNAP
- Q. STYLE
- R. TABLET
- S. UCS
- T. UCSICON
- U. DDUCS
- V. DDOSNAP
- W. GRIPS
- X. DDGRIPS
- Y. UNITS

VIII. Layer Commands to Place Entities into Specified Layer Options
- A. New layer
- B. Current layer

- C. Rename
- D. On and off
- E. Freeze and thaw
- F. Lock and unlock
- G. Set color
- H. Set linetype
- I. Filters
- J. DDLMODES

IX. Use Isometric Geometry Commands
  - A. Snap
  - B. Style
  - C. Isometric
  - D. Ellipse
  - E. Isometric circle

X. Use 3-D Surface and Object Commands
  - A. 3-D surface
    - 1. Edgesurf
    - 2. Rulesurf
    - 3. RevSurf
    - 4. TabSurf
    - 5. SurfTab1
    - 6. SurfTab2
    - 7. PEdit
    - 8. 3-DFace
    - 9. 3-DMesh
    - 10. PFace
    - 11. 3-DPoly
  - B. 3-D objects
    - 1. 3-D box
    - 2. Pyramid
    - 3. Wedge
    - 4. Dome
    - 5. Sphere
    - 6. Cone
    - 7. Torus
    - 8. Dish
    - 9. Mesh

XI. Use Utility to Manage Files
  - A. Audit
  - B. DXF/DFB
  - C. DXFIN
  - D. DXFOUT
  - E. DXBIN
  - F. IGES
  - G. IGESIN

H. IGESOUT
I. PURGE

XII. Use Utility Commands to Generate Slides, Script Files, and Access External Commands of the System
  A. Slide files
    1. MSlide
    2. VSlide
    3. Redraw
  B. Script files
    1. Script
    2. RScript
    3. Resume
    4. Delay
    5. Graphscr
    6. Textscr
  C. External commands
    1. Delete
    2. Directory
    3. Edit
    4. Type
    5. Shell

XIII. Use Keyboard to Manipulate Function Keys, Special Keys, Control, and Special Character Keys
  A. Function keys
    1. F1
    2. F6
    3. F7
    4. F8
    5. F9
    6. F10
  B. Special keys
    1. Ctrl "C"
    2. Ctrl "B"
    3. Ctrl "Q"
    4. Ctrl "G"
    5. Ctrl "D"
    6. Ctrl "E"
    7. Ctrl "T"
    8. Ctrl "V"
    9. Ctrl "X"
    10. Ctrl "Q"
  C. Control and special characteristics
    1. % %d
    2. % %c
    3. % %o

        4. % %p
        5. % %u
        6. % %nnn
        7. %%%
- XIV. Use Presentation Graphics and Rendering Commands
    - A. Light
    - B. VLight
    - C. Camera
    - D. VCamera
    - E. Scene
    - F. FilmRoll
    - G. Open
    - H. Quit
    - I. Shading
    - J. PlanView
    - K. WireFrame
    - L. Fast Shade
    - M. Full Shade
    - N. Replay
    - O. Replay all
    - P. Record
    - Q. Hard Copy
- XV. Use Solid Commands to Generate 3-D Solid Model Geometry
    - A. SOLBOX
    - B. SOLBOX (cube option)
    - C. SOLCONE
    - D. SOLCYL
    - E. SOLSPHERE
    - F. SOLTORUS
    - G. SOLWEDGE
    - H. SOLEXTRUDE
    - I. SOLREVOLVE
    - J. SOLIDIFY
- XV1. Use 3-D Solid Modifiers Commands
    - A. SOLINT
    - B. SOLSUB
    - C. SOLUNION
    - D. SOLSEP
    - E. SOLCUT
    - F. SOLCHAM
    - G. SOLFILL
    - H. SOLCHP
    - I. SOLMOVE
- XVII. Use Solid 3-D Inquiry Commands
    - A. LLIST

    - B. LMASSP
    - C. LAREA
    - D. LINTERF
- XVIII. Use Solid 3-D Representation Commands
    - A. SOLMESH
    - B. SOLWIRE
    - C. SOLFEAT
    - D. SOLPROF
    - E. SOLSECT
    - F. SOLHPAT
    - G. SOLHSIZE
    - H. SOLHANGLE
- XIX. Use Solid 3-D Utility Commands
    - A. SOLIN
    - B. SOLOUT
    - C. SOLMAT
    - D. SOLPURGE
    - E. SOLUCS
    - F. SOLVAR
    - G. UNLOAD
- XX. Use LISP Programs to Generate 3-D Solid Model Geometry
    - A. SOLMAINT
    - B. WBLKSOL
    - C. HOLE
    - D. STLSUP
- XXI. Use Application Programming Interface (API) Functions
    - A. TUTOR
    - B. ASM
    - C. DRILL
    - D. DESIGN
    - E. LAYOUT
    - F. SYMMETRY
    - G. OFFSOL
- XXII. Use Bonus 3-D Solid Feature Commands
    - A. SOLSTLOUT
    - B. SOLVIEW
    - C. AMELINK
- XXIII. Use CAD System to Digitize Paper Drawings
    - A. Tablet mode
    - B. Tablet on/off
    - C. Tablet calibration
    - D. Tablet configuration

Practical Application:

Students will access and maneuver within a CAD system. Each student will then create and dimension 3-D solid geometry models. The student will then use the display, settings, layers, surfaces, objects, and rendering commands to present their 3-D solid geometry model. Each student will use 3-D representation, utility, LISP, and bonus commands to graphically display and represent their 3-D solid geometry models.

Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this lesson, along with assigned projects pertaining to topics covered.

Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-H6) dealing with using Computer-Aided Manufacturing (CAM) system.

TLD-H5-HO
Create 3-D Solid Models
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Access and maneuver within a CAD system;
b. Create 3-D solid geometry models;
c. Dimension 3-D geometry;
d. Display commands to generate prototype borders;
e. Display commands to control drawing representation on the screen;
f. Display commands used to generate and manipulate viewports;
g. Setting commands to assist with 3-D geometry;
h. Layer commands to place entities into specified layer options;
i. Use isometric geometry commands;
j. Use 3-D surface and object commands;
k. Use utility to manage files;
l. Use utility commands to generate slides, script files, and access external commands of the system;
m. Use keyboard to manipulate function keys, special keys, control, and special character keys;
n. Use presentation graphics and rendering commands;
o. Use solid commands to generate 3-D solid model geometry;
p. Use 3-D solid modifiers commands;
q. Use solid 3-D inquiry commands;
r. Use solid 3-D representation commands;
s. Use solid 3-D utility commands;
t. Use LISP programs to generate 3-D solid model geometry;
u. Use Application Programming Interface (API) functions;
v. Use bonus 3-D solid feature commands; and,
w. Use CAD system to digitize paper drawings.

Module Outline:

I. Access and Maneuver Within a CAD System
    A. Use Disk Operating System commands
    B. Use the initial graphics editor within a CAD system
II. Create 3-D Solid Geometry Models
    A. Use the blocks and attributed commands
        1. Block
        2. Insert
        3. DDInsert
        4. MInset

    - 5. WBlock
    - 6. 3-DBlock
    - 7. Attributes
    - 8. DDATTDEF
    - 9. ATTDEF
    - 10. ATTDISP
    - 11. ATTEDIT
    - 12. DDATTE
    - 13. DDATTEXT
    - 14. ATTEXT
- III. Dimension 3-D Geometry
  - A. Dim and Dim1
  - B. Associative dimensioning drawing commands
    - 1. Linear
    - 2. Angular
    - 3. Diameter
    - 4. Radius
    - 5. Ordinate
    - 6. Aligned
    - 7. Baseline
    - 8. Center
    - 9. Continue
    - 10. Vertical
    - 11. Horizontal
    - 12. Rotated
  - C. Dimension style command
    - 1. Override
    - 2. Restore
    - 3. Save
    - 4. Variable
    - 5. Style name
  - D. Dimension editing commands
    - 1. Hometext
    - 2. Newtext
    - 3. Oblique
    - 4. Tedit
    - 5. Trotate
    - 6. Update
  - E. Dimension utility commands
    - 1. Exit
    - 2. Leader
    - 3. Redraw
    - 4. Status
    - 5. Style
    - 6. Undo

    F. Dimension variable commands
        1. DIMALT
        2. DIMALTD
        3. DIMALTF
        4. DIMAPOST
        5. DIMASO
        6. DIMAZ
        7. DIMBLK
        8. DIMCEN
        9. DIMCLRD
        10. DIMCLRE
        11. DIMCLRT
        12. DIMDLE
        13. DIMDLI
        14. DIMEXE
        15. DIMEXO
        16. DIMGAP
        17. DIMLFAC
        18. DIMLIM
        19. DIMPOST
        20. DIMRND
        21. DIMSAH
        22. DIMSCALE
        23. DIMSE1
        24. DIMSE2
        25. DIMSHO
        26. DIMTAD
        27. DIMTFAC
        28. DIMTIH
        29. DIMTIX
        30. DIMTM
        31. DIMTOFL
        32. DIMTOH
        33. DIMTOL
        34. DIMTP
        35. DIMTSZ
        36. DIMTVP
        37. DIMTXT
        38. DIMZIN
IV. Display Commands to Generate Prototype Borders
    A. View
    B. Layout
    C. MVSetup
V. Display Commands to Control Drawing Representation on the Screen
    A. View

  - B. DView
  - C. DView Slide Bar
  - D. Plan
  - E. Vpoint
  - F. Shade
  - G. Zoom
  - H. Redraw
  - I. Pan
  - J. Hide
  - K. Viewports
  - L. REGEN
  - M. REDRAWALL
  - N. REGENALL
  - O. REGENAUTO
  - P. VIEWERS
  - Q. FILL
- VI. Display Commands Used to Generate and Manipulate Viewports
  - A. MView
  - B. On
  - C. Off
  - D. HidePlot
  - E. Fit
  - F. MView
  - G. MSpace
  - H. PSpace
  - I. TileMode
  - J. VPlayer
- VII. Setting Commands to Assist With 3-D Geometry
  - A. DDEMODES
  - B. DDRMODES
  - C. APERTURE
  - D. AXIS
  - E. BLIPS
  - F. COLOR
  - G. DRAGMODE
  - H. ELEVATION
  - I. GRID
  - J. LINETYPE
  - K. LIMITS
  - L. LTSCALE
  - M. OSNAP
  - N. QTEXT
  - O. SETVARIABLE
  - P. SNAP
  - Q. STYLE

- R. TABLET
- S. UCS
- T. UCSICON
- U. DDUCS
- V. DDOSNAP
- W. GRIPS
- X. DDGRIPS
- Y. UNITS

VIII. Layer Commands to Place Entities into Specified Layer Options
- A. New layer
- B. Current layer
- C. Rename
- D. On and off
- E. Freeze and thaw
- F. Lock and unlock
- G. Set color
- H. Set linetype
- I. Filters
- J. DDLMODES

IX. Use Isometric Geometry Commands
- A. Snap
- B. Style
- C. Isometric
- D. Ellipse
- E. Isometric circle

X. Use 3-D Surface and Object Commands
- A. 3-D surface
  1. Edgesurf
  2. Rulesurf
  3. RevSurf
  4. TabSurf
  5. SurfTab1
  6. SurfTab2
  7. PEdit
  8. 3-DFace
  9. 3-DMesh
  10. PFace
  11. 3-DPoly
- B. 3-D objects
  1. 3-D box
  2. Pyramid
  3. Wedge
  4. Dome
  5. Sphere
  6. Cone

        7. Torus
        8. Dish
        9. Mesh

XI. Use Utility to Manage Files
    A. Audit
    B. DXF/DFB
    C. DXFIN
    D. DXFOUT
    E. DXBIN
    F. IGES
    G. IGESIN
    H. IGESOUT
    I. PURGE

XII. Use Utility Commands to Generate Slides, Script Files, and Access External Commands of the System
    A. Slide files
        1. MSlide
        2. VSlide
        3. Redraw
    B. Script files
        1. Script
        2. RScript
        3. Resume
        4. Delay
        5. Graphscr
        6. Textscr
    C. External commands
        1. Delete
        2. Directory
        3. Edit
        4. Type
        5. Shell

XIII. Use Keyboard to Manipulate Function Keys, Special Keys, Control, and Special Character Keys
    A. Function keys
        1. F1
        2. F6
        3. F7
        4. F8
        5. F9
        6. F10
    B. Special keys
        1. Ctrl "C"
        2. Ctrl "B"
        3. Ctrl "Q"

    4. Ctrl “G”
    5. Ctrl “D”
    6. Ctrl “E”
    7. Ctrl “T”
    8. Ctrl “V”
    9. Ctrl “X”
    10. Ctrl “Q”
  C. Control and special characteristics
    1. % %d
    2. % %c
    3. % %o
    4. % %p
    5. % %u
    6. % %nnn
    7. %%%

XIV. Use Presentation Graphics and Rendering Commands
  A. Light
  B. VLight
  C. Camera
  D. VCamera
  E. Scene
  F. FilmRoll
  G. Open
  H. Quit
  I. Shading
  J. PlanView
  K. WireFrame
  L. Fast Shade
  M. Full Shade
  N. Replay
  O. Replay all
  P. Record
  Q. Hard Copy

XV. Use Solid Commands to Generate 3-D Solid Model Geometry
  A. SOLBOX
  B. SOLBOX (cube option)
  C. SOLCONE
  D. SOLCYL
  E. SOLSPHERE
  F. SOLTORUS
  G. SOLWEDGE
  H. SOLEXTRUDE
  I. SOLREVOLVE
  J. SOLIDIFY

XV1. Use 3-D Solid Modifiers Commands

A. SOLINT
B. SOLSUB
C. SOLUNION
D. SOLSEP
E. SOLCUT
F. SOLCHAM
G. SOLFILL
H. SOLCHP
I. SOLMOVE

XVII. Use Solid 3-D Inquiry Commands
A. LLIST
B. LMASSP
C. LAREA
D. LINTERF

XVIII. Use Solid 3-D Representation Commands
A. SOLMESH
B. SOLWIRE
C. SOLFEAT
D. SOLPROF
E. SOLSECT
F. SOLHPAT
G. SOLHSIZE
H. SOLHANGLE

XIX. Use Solid 3-D Utility Commands
A. SOLIN
B. SOLOUT
C. SOLMAT
D. SOLPURGE
E. SOLUCS
F. SOLVAR
G. UNLOAD

XX. Use LISP Programs to Generate 3-D Solid Model Geometry
A. SOLMAINT
B. WBLKSOL
C. HOLE
D. STLSUP

XXI. Use Application Programming Interface (API) Functions
A. TUTOR
B. ASM
C. DRILL
D. DESIGN
E. LAYOUT
F. SYMMETRY
G. OFFSOL

XXII. Use Bonus 3-D Solid Feature Commands

A. SOLSTLOUT
B. SOLVIEW
C. AMELINK

XXIII. Use CAD System to Digitize Paper Drawings
A. Tablet mode
B. Tablet on/off
C. Tablet calibration
D. Tablet configuration

Name______________________________ Date______________________

TLD-H5
Create 3-D Solid Models
Self-Assessment

1. List and define five Disk Operating System commands.

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2. Identify and define four parts of the graphic editor within a CAD system.

____

____

____

____

3. What type of block commands are used to generate 3-D solid geometry?

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4. What type of attribute commands are used to generate 3-D solid geometry?

____

____

____

5. List three dimensioning commands used to dimension 3-D geometry.

____

____

____

6. List and define two dimension styles used to dimension 3-D geometry.

____

____

____

7. Name and describe three dimension editing commands used to dimension 3-D geometry.

____

____

____

8. Identify three dimension utility commands used to dimension 3-D geometry.

9. What are four dimension variable commands used to dimension 3-D geometry?

10. List and define two display commands used to generate prototype borders.

11. Identify and describe four display commands used to control drawing representation on the screen.

12. Name three display commands used to generate and manipulate viewports.

13. List and define five setting commands used to assist with generating 3-D geometry.

14. Identify and describe four layer entity commands used to assist with generating 3-D geometry.

15. List and define three isometric geometry commands.

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____
____

16. Name and describe three 3-D object commands.

____
____
____

17. Identify and define three 3-D surface commands.

____
____
____

18. What are three utility commands used to manage various types of files?

____
____
____

19. What are three utility commands used to generate slides?

____
____
____

20. What are three utility commands used to generate script files?

____
____
____

21. What are three external commands used on the system?

____
____
____

22. Identify four function keys used with the system to assist with the generation of 3-D geometry.

____
____
____
____

23. **Name and describe five special keys used with the system to assist with the generation of 3-D geometry.**

24. **List and define three control or special character keys used with the system to assist with the generation of 3-D geometry.**

25. **Identify and describe four 3-D render commands used to present 3-D geometry.**

26. **Name and define four 3-D solid commands used to generate 3-D geometry.**

27. **List and define three 3-D solid modifiers used to assist in the generation of 3-D geometry.**

28. **Identify and describe two 3-D solid inquiry commands used to assist in the generation of 3-D geometry.**

29. **Name and define four 3-D solid representation commands.**

30. List and describe three 3-D solid utility commands.

31. Identify and define three 3-D LISP programs used to assist in the generation of 3-D geometry.

32. Name and describe three Application Programming Interface functions used to assist in the generation of 3-D geometry.

33. List and define three 3-D solid feature commands.

34. Identify and describe three commands used to digitize paper drawings using the CAD system.

TOOL & DIE and EDM SERIES

MASTER Technical Module No. TLD-H6

Subject: Tool & Die and EDM **Time:** 30-50 Hrs.

Duty: Perform CAD/CAM and CNC Programming Tasks
Task: Use Computer-Aided Manufacturing (CAM) System

Objectives:

Upon completion of this unit the student will be able to:

1. Access CAD program options; and,
2. Create basic geometric entities.

Instructional Materials:

MASTER Handout (TLD-H6-HO)
MASTER Laboratory Aid (TLD-H6-LA)

References:

There are not many books available that discuss CAD/CAM with an emphasis on CAM, but normally there is an instructional manual that comes with the purchase of the software packages.

In the area of CAD there are many after market books available. Please check to see what is available for your software.

If you are using either MasterCam or SurfCam, there is now an aftermarket book for each. To get more information about these books contact:

Dr. Su-Chen Jonathan Lin
Scholars International Publishing Corporation
2675 Georgetown Blvd.
Ann Arbor, MI. 48105
Telephone: (313) 930-0813
Fax. Number: (313) 741-1927

Student Preparation:

Students should have previously completed the following Technical Modules:

TLD-H1 "Discuss Fundamentals of CNC Machines and Controls"
TLD-H2 "Program and Operate CNC Milling Machine and Machining Center"

TLD-H3	"Program and Operate CNC Lathe"
TLD-H4	"Use Computer-Aided Drafting (CAD) System"
TLD-H5	"Create 3-D Solid Models"

Introduction:

Part I:

In this module we will discuss the actual use of CAD/CAM software to create electronic images. For those students who are using MasterCam you will notice that the information listed in the outline below relates directly to the menu commands in MasterCam.

For those of you who are not using MasterCam, your software will have menu selections that, although they are not the exactly the same as the ones listed in the outline below, they will have similar commands to perform the same type operations.

Also for anyone using either MasterCam or SurfCam, I would recommend the book listed in the resource section of this outline written by Dr. Jonathan Lin.

For those of you who are using some other company's software, there should be some type of written information that will allow you to become familiar with the basic operations listed below.

Part II:

There is no doubt that in the long term CAD/CAM saves a tremendous amount of time, and is much more flexible than paper drawings. Having made this statement it is important to note that the process of using CAD/CAM software to generate designs is a process that can be very time consuming. There is no automatic design creation that I am aware of as of this writing. Using computers to create designs is like everything else: it takes practice to become good at it.

The outline listed below covers the basic geometric elements used in creating designs. This outline only discusses wire frame geometry creation; it does not discuss either surface modeling or solid modeling. Wire frame design, although not as sophisticated as surfaces and solid modeling, encompasses the building blocks that will be used later on in more advanced CAD designs.

In CNC/CAM, we are interested in CAD as a method of generating the necessary geometric entities that will allow us to guide a cutting tool along a defined boundary or a set of boundaries to create the necessary information that will control the actions of a CNC machine tool to create a machined part to given specifications.

When we have completed the CAD component, we are only getting started. We then have to complete the CAM component as required to move onto the CNC machine.

In the overall process of CAD/CAM/CNC, the CAD section can often consume a vast majority of the time used in completion of a manufactured object. The ability to create a quality design in a short amount of time is definitely an important part of the complete process.

Presentation Outline:

I. Access CAD Program Options
   A. Explain the configuration of CAD/CAM software
      1. Explain configuration of:
         a File and path names
         b. Installation, including DOS and Windows
         c. Configure software
         d. Interaction of files between each other
      2. Describe the "flow" process of CAD/CAM
   B. Access CAD software
      1. Access CAD software, including AutoCAD and CadKey, to:
         a. Create basic 2-dimensional designs
         b. Create 3-dimension designs
         c. Dimension designs to be used as drawings
         d. Create title blocks and borders for prints
         e. Print drawings
         f. Plot drawings
         g. Create general and local drawing notes and tolerances
      2. Describe various file conversion formats
      3. Import and export designs using conversions, including:
         a. IGES
         b. CADL
         c. DXF
         d. STL
   C. Access CAM software
      1. Load existing design
      2. Import and export design files from various file format standards, including:
         a. IGES
         b. DXF
         c. CADL
         d. STL
      3. Save design files to "permanent" memory
      4. Access CAD section of CAM software to create
         a. Create basic 2-dimensional designs

        - b. Create 3-dimension designs
        - c. Dimension designs to be used as drawings
        - d. Create title blocks and borders for prints
        - e. Print drawings
        - f. Plot drawings
        - g. Create general and local drawing notes and tolerances

II. Create Basic Geometric Entities

- A. Create basic geometric entities, including:
    1. Points
    2. Fillets
    3. Lines
    4. Splines
    5. Arcs
    6. Chamfers
    7. Circles
    8. Letters including various machinable fonts
- B. Dimension completed designs to create detailed drawings
- C. Transform geometric entities using CAD commands
    1. Transform geometric entities, including:
        - a. Mirror entities
        - b. Rotate entities
        - c. Scale complete entities using single scale option
        - d. Translate using move and copy options
        - e. Offset single and grouped geometric entities
        - f. Use group function to effect multiple entities simultaneously
        - g. Use result function to effect group movements
- D. Set menu selections to:
    1. View planes
    2. Construction planes
    3. Color choices
- E. Use Delete command:
    1. Use Delete commands, including:
        - a. Chained and duplicate entities
        - b. Exclusive entities (only)
        - c. Inclusive entities (all)
        - d. Enclosed in window
        - e. Intersecting window
- F. Execute screen and display functions
    1. Use screen and display functions to:
        - a. List screen statistics
        - b. Display entity endpoints
        - c. Clear group and result color designation
        - d. Change colors of entities
        - e. Display window

- f. Un-zoom display
- g. Change levels of entities
- h. Fit entities to screen
- i. Set various view ports
- j. Refresh screen
- k. Change views
- l. Set active levels
- m. Change entities between levels
- m. Set screen center "pan"
- n. Initialize display "clear"
- o. Rotate display

G. Use analyze function
- 1. Use analyze function to interpret:
  - a. Point descriptions
  - b. Single entity information
  - c. Locations of entities
  - d. Distance between points
  - e. Area calculations
  - f. Calculation of angles

Practical Application:

For those of you that are using the Jonathan Lin book it is recommended that you complete the first 8 chapters of the book. Concern yourself with the CAD design for this module only.

It is also suggested that the Instructor interject some basic designs that they may get from local companies, this will give the students the experience of working on real drawings.

For those of you who will not be using the Lin book, most CAD/CAM software comes with a basic instruction book that may include basic designs. In addition, as stated above, the Instructor may add some basic drawings that would be used by local companies as an addition to the designs provided in the instructional books.

Evaluation and/or Verification:

A combination of written and hands-on testing should be used to establish the proficiency of the students.

For the written portion of the test a multiple choice test is recommended. Jonathan Lin's book has tests at the end of each chapter. These can be used as sample tests.

For the hands on testing, all students should create the same design and record their time. The time is then used to generate their grade for the hands on portion of the test. To tabulate a student's overall grade, written test time with the student's hands on test time are averaged.

Summary:

Review the main lesson points and answer students questions

Next Lesson Assignment:

MASTER Technical Module (TLD-I1) dealing with basic types and functions of jigs and fixtures.

TLD-H6-HO
Use Computer-Aided Manufacturing (CAM) System
Attachment 1: MASTER Handout

Objectives:

Upon completion of this unit the student will be able to:

1. Access CAD program options; and,
2. Create basic geometric entities.

Module Outline:

I. Access CAD Program Options
  A. Explain the configuration of CAD/CAM software
    1. Explain configuration of:
      a File and path names
      b. Installation, including DOS and Windows
      c. Configure software
      d. Interaction of files between each other
    2. Describe the "flow" process of CAD/CAM
  B. Access CAD software
    1. Access CAD software, including AutoCAD and CadKey, to:
      a. Create basic 2-dimensional designs
      b. Create 3-dimension designs
      c. Dimension designs to be used as drawings
      d. Create title blocks and borders for prints
      e. Print drawings
      f. Plot drawings
      g. Create general and local drawing notes and tolerances
    2. Describe various file conversion formats
    3. Import and export designs using conversions, including:
      a. IGES
      b. CADL
      c. DXF
      d. STL
  C. Access CAM software
    1. Load existing design
    2. Import and export design files from various file format standards, including:
      a. IGES
      b. DXF
      c. CADL
      d. STL
    3. Save design files to "permanent" memory

    4. Access CAD section of CAM software to create
        a. Create basic 2-dimensional designs
        b. Create 3-dimension designs
        c. Dimension designs to be used as drawings
        d. Create title blocks and borders for prints
        e. Print drawings
        f. Plot drawings
        g. Create general and local drawing notes and tolerances

II. Create Basic Geometric Entities
- A. Create basic geometric entities, including:
    1. Points
    2. Fillets
    3. Lines
    4. Splines
    5. Arcs
    6. Chamfers
    7. Circles
    8. Letters including various machinable fonts
- B. Dimension completed designs to create detailed drawings
- C. Transform geometric entities using CAD commands
    1. Transform geometric entities, including:
        a. Mirror entities
        b. Rotate entities
        c. Scale complete entities using single scale option
        d. Translate using move and copy options
        e. Offset single and grouped geometric entities
        f. Use group function to effect multiple entities simultaneously
        g. Use result function to effect group movements
- D. Set menu selections to:
    1. View planes
    2. Construction planes
    3. Color choices
- E. Use Delete command:
    1. Use Delete commands, including:
        a. Chained and duplicate entities
        b. Exclusive entities (only)
        c. Inclusive entities (all)
        d. Enclosed in window
        e. Intersecting window
- F. Execute screen and display functions
    1. Use screen and display functions to:
        a. List screen statistics
        b. Display entity endpoints
        c. Clear group and result color designation

        - d. Change colors of entities
        - e. Display window
        - f. Un-zoom display
        - g. Change levels of entities
        - h. Fit entities to screen
        - i. Set various view ports
        - j. Refresh screen
        - k. Change views
        - l. Set active levels
        - m. Change entities between levels
        - m. Set screen center "pan"
        - n. Initialize display "clear"
        - o. Rotate display
- G. Use analyze function
    - 1. Use analyze function to interpret:
        - a. Point descriptions
        - b. Single entity information
        - c. Locations of entities
        - d. Distance between points
        - e. Area calculations
        - f. Calculation of angles

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and,
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

TOOL AND DIE MAKER .... skilled workers who produce tools, dies, and special guiding and holding devices that are used in machining.

Duties		Tasks												
A	Practice Safety	A-1 Follow safety manuals and all safety regulations/ requirements	A-2 Maintain safe equipment and machinery	A-3 Use safe operating procedures for hand and machine tools	A-4 Maintain a clean and safe work environment	A-5 Use safe material handling practices	A-6 Consult and apply MSDS for hazards of various materials							
B	Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Perform basic algebraic operations	B-3 Use basic geometric principles	B-4 Perform basic trigonometric functions	B-5 Use and apply Cartesian Coordinate System								
C	Interpret Engineering Drawings and Related Documents	C-1 Interpret and understand basic layout/types of drawings	C-2 Interpret, review, and apply blueprint notes, dimensions, and tolerances	C-3 Use and apply Geometric Dimensioning and Tolerancing (GD&T)	C-4 Demonstrate traditional mechanical drafting and sketching techniques	C-5 Understand and use quality systems								
D	Demonstrate Knowledge of Manufacturing Materials	D-1 Identify materials with desired properties	D-2 Identify materials and processes to produce a part	D-3 Discuss classification systems for metal										
E	Measure/ Inspect	E-1 Understand metrology terms	E-2 Select measurement tools	E-3 Measure with hand held instruments	E-4 Eliminate measurement variables	E-5 Measure/inspect using surface plate and accessories	E-6 Inspect using stationary equipment							
F	Demonstrate Knowledge of Manufacturing Processes	F-1 Discuss metal cutting and metal cutting tools	F-2 Operate metal saws	F-3 Operate drill presses and tooling	F-4 Operate engine and turret lathes and tooling	F-5 Operate vertical and horizontal mills and tooling	F-6 Operate precision grinders	F-7 Operate heat treating equipment and processes	F-8 Operate sheet metal equipment	F-9 Operate welding equipment and processes	F-10 Estimate time required/ cost to produce a part			
G	Use Computers	G-1 Use computer operating systems	G-2 Understand computer terminology	G-3 Use file management systems	G-4 Install and use software packages									
H	Perform CAD/ CAM and CNC Programming Tasks	H-1 Discuss fundamentals of CNC machines and controls	H-2 Program and operate CNC milling machine and machining center	H-3 Program and operate CNC lathe	H-4 Use Computer-Aided Drafting (CAD) system	H-5 Create 3-D solid models	H-6 Use Computer-Aided Manufacturing (CAM) system							
I	Perform Tool and Die Making Operations	I-1 Discuss basic types and functions of jigs and fixtures	I-2 Utilize concepts of jig and fixture design	I-3 Demonstrate understanding of different types of industrial dies	I-4 Utilize basic die theory	I-5 Utilize principles of die design	I-6 Perform tool and die repair	I-7 Demonstrate tool and die making skills						
J	Operate Electrical Discharge Machine (EDM)	J-1 Discuss fundamentals of EDM	J-2 Setup and operate conventional sinker EDM	J-3 Program, setup, and operate CNC sinker EDM and EDM drill	J-4 Program, setup, and operate CNC wire EDM									

TLD [illegible]
[illegible]

TLD-I1

TOOL & DIE and EDM SERIES

MASTER Technical Module No. TLD-I1

Subject: **Tool & Die and EDM** **Time: 6 Hrs.**

Duty: **Perform Tool and Die Making Operations**
Task: Discuss Basic Types and Functions of Jigs and Fixtures

Objective(s):

Upon completion of this unit the student will be able to:
a. Distinguish between jigs and fixtures;
b. Discuss boring and drill jigs;
c. Discuss open and closed (box) jigs;
d. Discuss the various names used to identify jig types; and,
e. Discuss the various types and functions of fixtures.

Instructional Materials:

MASTER Handout (TLD-I1-HO)
MASTER Self-Assessment

References:

Jig and Fixture Design, Edward G. Hoffman, Delmar Publishing, Latest Edition
Instructor's Guide, Jig and Fixture Design, Edward G. Hoffman, Delmar Publishing, Latest Edition
Handbook of Jig and Fixture Design, W. Boyes, ed., Society of Manufacturing Engineers, Latest Edition
NTMA Machinist Training Program Module(s), National Tooling and Machining Association, 9399 Livingston Road, Fort Washington, MD 20744
Basic Fixture Design, Paul Campbell, Industrial Press, Latest Edition
Fundamentals of Tool Design, David A. Smith, ed., Society of Manufacturing Engineers, Latest Edition
Jig and Fixture Design Manual, Erik K. Henriksen, Industrial Press, Latest Edition
Jig and Fixture Handbook, Carr Lane Mfg. Co., Latest Edition
Tool Design, Donaldson, Goold, and LeCain, McGraw-Hill, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:

TLD-A1 through TLD-A6	"Practice Safety"
TLD-B1 through TLD-B5	"Apply Mathematical Concepts"
TLD-C1 through TLD-C5	"Interpret Engineering Drawings and Related Documents"
TLD-D1 through TLD-D3	"Demonstrate Knowledge of Manufacturing Materials"
TLD-E1 through TLD-E6	"Measure/Inspect"
TLD-F1 through TLD-F10	"Demonstrate Knowledge of Manufacturing Processes"

Introduction:

With the demand for increased production and tighter tolerances facing manufacturing companies, emphasis is being placed on more efficient and cost-effective tooling. Managers are constantly seeking ways of improving tooling performance, decreasing setup and change-over times, and increasing production. An appropriate jig or fixture, in many cases, will determine the success of a particular product within a company. Tool designers have responded with more complex and precise workholding methods and devices, placing greater demands on toolmakers. A prerequisite, therefore, for toolmakers is a knowledge of the various types and functions of tooling used in industry.

Presentation Outline:

I. Distinguish Between Jigs and Fixtures and Discuss Need and Characteristics of Each
II. Discuss Various Applications of Jigs and Fixtures
  A. External-machining
  B. Internal-machining
  C. Non-machining
III. Identify Two General Classes of Jigs
  A. Boring jigs
  B. Drill jigs
IV. Discuss Types of Open Jigs
  A. Template jigs
  B. Plate jigs
  C. Table jigs
  D. Sandwich jigs
  E. Angle-plate jigs
V. Discuss Types of Closed Jigs
  A. Box, or tumble, jigs

    - B. Channel jigs
    - C. Leaf jigs
- VI. Discuss Types of Jigs Which Can Be Either Open or Closed
    - A. Indexing, or rotary, jigs
    - B. Trunnion jigs
    - C. Pump jigs
    - D. Multi-station jigs
- VII. Discuss Types and Functions of Fixtures
    - A. Plate fixtures
    - B. Angle-plate fixtures
    - C. Vise-jaw fixtures
    - D. Indexing fixtures
    - E. Multi-station fixtures
    - F. Profiling fixtures
- VIII. Discuss Classification of Fixtures by Machine Type or Operation
- IX. Discuss Modular Fixturing
    - A. Sub-plate systems
    - B. "T"-slot systems
    - C. Dowel-pin systems

Practical Application:

Students should be shown actual examples of as many types of jigs and fixtures as possible, along with the actual parts and operations to be performed. If feasible, a demonstration of the jig and/or fixture operation would be helpful as well.

Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-I2) dealing with utilizing concepts of jig and fixture design.

TLD-I1-HO
Discuss Basic Types and Functions of Jigs and Fixtures
Attachment 1: **MASTER** Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Distinguish between jigs and fixtures;
b. Discuss boring and drill jigs;
c. Discuss open and closed (box) jigs;
d. Discuss the various names used to identify jig types; and,
e. Discuss the various types and functions of fixtures.

Module Outline:

I. Distinguish Between Jigs and Fixtures and Discuss Need and Characteristics of Each
II. Discuss Various Applications of Jigs and Fixtures
    A. External-machining
    B. Internal-machining
    C. Non-machining
III. Identify Two General Classes of Jigs
    A. Boring jigs
    B. Drill jigs
IV. Discuss Types of Open Jigs
    A. Template jigs
    B. Plate jigs
    C. Table jigs
    D. Sandwich jigs
    E. Angle-plate jigs
V. Discuss Types of Closed Jigs
    A. Box, or tumble, jigs
    B. Channel jigs
    C. Leaf jigs
VI. Discuss Types of Jigs Which Can Be Either Open or Closed
    A. Indexing, or rotary, jigs
    B. Trunnion jigs
    C. Pump jigs
    D. Multi-station jigs
VII. Discuss Types and Functions of Fixtures
    A. Plate fixtures
    B. Angle-plate fixtures
    C. Vise-jaw fixtures
    D. Indexing fixtures

  E. Multi-station fixtures
  F. Profiling fixtures

VIII. Discuss Classification of Fixtures by Machine Type or Operation

IX. Discuss Modular Fixturing
  A. Sub-plate systems
  B. "T"-slot systems
  C. Dowel-pin systems

Name____________________________ Date________________

TLD-I1
Discuss Basic Types and Functions of Jigs and Fixtures
Self-Assessment

1. Define jig.

____

____

____

2. Define fixture.

____

____

____

3. List 2 external-machining applications of jigs and fixtures. Give an example of a type of jig or fixture for each.

____

____

____

4. List an internal-machining application of a jig or fixture and give an example.

____

____

____

5. List 2 non-machining applications of jigs and fixtures and give examples of each.

____

____

____

6. What are the two general classes that jigs are divided into?

____

____

____

7. How are fixtures normally classified and/or subclassified?

____

____

____

8. Give 5 examples of fixture classification. Include a subclassification for at least 2 of them.

____

____

____

____

____

9. A/An ____________ jig is the least expensive and simplest to use. It fits over, on, or into the work and is not usually clamped. If bushings are not used, the entire jig plate is hardened.
a. Closed
b. Sandwich
c. Template
d. Angle-plate

10. _________ jigs are a form of plate jig with a back plate for support of thin or soft parts which could bend or warp during the operation.
a. Angle-plate
b. Channel
c. Closed
d. Sandwich

11. _________ jigs are similar to templates. The primary difference is built-in clamps to hold the work.
a. Plate
b. Angle-plate
c. Box, or tumble
d. Closed

12. For large work, plate jigs are sometimes made with legs to raise the jig off the table. This type jig is called a ________________.
a. Leaf jig
b. Box, or tumble jig
c. Table jig
d. Trunnion jig

13. To machine a part at right angles to the mounting locators, a/an ______________ jig is used.
a. Modified box
b. Indexing
c. Multi-station
d. Angle-plate

14. __________ jigs usually totally surround the part, allowing it to be completely machined on every surface without repositioning.
   a. Rotary
   b. Box
   c. Tumble
   d. Both b and c

15. Which of the following are types of box jigs?
   a. Channel and leaf
   b. Sandwich and plate
   c. Trunnion and channel
   d. Indexing and rotary

16. These jigs are used to accurately space a machining operation around a part.
   a. Trunnion
   b. Spacing jigs
   c. Indexing, or rotating
   d. Both a and c

17. __________ fixtures are used for machining small parts. Usually standard vise jaws are replaced with formed jaws that fit the part.
   a. Sandwich
   b. Formed
   c. Profiling
   d. Vise-jaw

18. Gears and splines are examples of shapes machined with a/an __________ fixture.
   a. Template
   b. Indexing
   c. Duplex
   d. Both b and c

19. A straddle-milling fixture is __________.
   a. A milling fixture designed to straddle the piece part
   b. A straddle fixture designed for use on a milling machine
   c. A fixture designed to be used on a mill and whose purpose is straddle milling
   d. A fixture (for any machine) that references the part from a straddle milled area

20. Multi-station fixtures are used primarily for ___________.
   a. High speed, high volume production runs where the machining cycle must be continuous
   b. Low speed, high volume production runs where the machining cycle is divided by transit time between operations
   c. High speed, high volume production runs requiring multiple parts to be machined simultaneously
   d. Instances requiring mating parts to be machined together, using one setup and one reference point

21. Modular workholding is ___________.
   a. Tooling customized for only one style and size part
   b. Special purpose, or permanent, workholders
   c. Special purpose workholders assembled from general-purpose (standard) components
   d. Tooling designed for modular machines

22. What applications are ideal for modular workholding? ___________
   a. One-time jobs
   b. Infrequent production runs
   c. Recurring production runs
   d. Both a and b

23. Which modular system of workholding uses a series of precisely machined base plates and mounting blocks with machined and ground "T" slots?

____
   a. Angle-plate systems
   b. Dowel-pin systems
   c. Bolt type systems
   d. None of the above

24. Which modular systems uses a grid pattern of holes to locate and mount other accessories? ___________
   a. Angle-plate systems
   b. Dowel-pin systems
   c. Bolt type systems
   d. None of the above

25. A major advantage of dowel-pin systems over other systems is better clamping. This statement is __________.
   a. True
   b. False
   c. True for most situations; False for some
   d. Neither. There is no advantage or disadvantage to dowel-pin systems.

TLD-I2

TOOL & DIE and EDM SERIES

MASTER Technical Module No. TLD-I2

Subject: **Tool & Die and EDM** **Time: 6 Hrs.**

Duty: **Perform Tool and Die Making Operations**
Task: Utilize Concepts of Jig and Fixture Design

Objective(s):

Upon completion of this unit the student will be able to:
a. Identify basic components of jigs and fixtures;
b. Discuss supporting and locating principles;
c. Discuss clamping and workholding principles; and,
d. Discuss basic construction principles.

Instructional Materials:

MASTER Handout (TLD-I2-HO)
MASTER Laboratory Aid (TLD-I2-LA)
MASTER Self-Assessment

References:

Jig and Fixture Design, Edward G. Hoffman, Delmar Publishing, Latest Edition
Instructor's Guide, Jig and Fixture Design, Edward G. Hoffman, Delmar Publishing, Latest Edition
Handbook of Jig and Fixture Design, W. Boyes, ed., Society of Manufacturing Engineers, Latest Edition
NTMA Machinist Training Program Module(s), National Tooling and Machining Association, 9399 Livingston Road, Fort Washington, MD 20744
Basic Fixture Design, Paul Campbell, Industrial Press, Latest Edition
Fundamentals of Tool Design, David A. Smith, ed., Society of Manufacturing Engineers, Latest Edition
Jig and Fixture Design Manual, Erik K. Henriksen, Industrial Press, Latest Edition
Jig and Fixture Handbook, Carr Lane Mfg. Co., Latest Edition
Tool Design, Donaldson, Goold, and LeCain, McGraw-Hill, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:

TLD-I1 "Discuss Basic Types and Functions of Jigs and Fixtures"

Introduction:

Toolmakers and tool designers share the responsibility of the success of a particular jig or fixture. They must work together to produce a functional tool that fulfills its intent and is of the highest quality. This requires that each maintains a basic knowledge of the other's functions. It is imperative that tool designers have an understanding of toolmaking fundamentals in order to ensure the tool can reasonably be manufactured. It is also imperative that toolmakers have knowledge of the basic principles of tool design in order to better interpret the design and to construct the tool in the best possible manner. For this reason, many toolmakers are eventually moved to design positions to take advantage of their expertise in both areas.

Presentation Outline:

I. Generally Discuss the Following Components of Jigs and Fixtures
    A. Tool bodies and plates (or bases)
    B. Locators
    C. Clamping or locking devices
    D. Bushings or guides
    E. Supports
    F. Keys
    G. Feet or legs
II. Define and Discuss Supporting and Locating Principles
    A. Referencing
    B. Repeatability
    C. Locator position
    D. Tool tolerance (relative to part tolerance)
    E. Foolproofing
    F. The twelve planes of movement ("degrees of freedom")
    G. The three forms of location: plane, concentric, and radial
    H. External and internal locating
III. Discuss the Primary Types of Supports
    A. Solid
    B. Adjustable
    C. Equalizing
IV. Discuss Locator Types
    A. Locating pins
    B. Nesting locators
    C. Vee locators

    C. Locator position
    D. Tool tolerance (relative to part tolerance)
    E. Foolproofing
    F. The twelve planes of movement ("degrees of freedom")
    G. The three forms of location: plane, concentric, and radial
    H. External and internal locating

III. Discuss the Primary Types of Supports
    A. Solid
    B. Adjustable
    C. Equalizing

IV. Discuss Locator Types
    A. Locating pins
    B. Nesting locators
    C. Vee locators
    D. Fixed-stop locators
    E. Adjustable locators
    F. Sight locators
    G. Spring-loaded devices

V. Discuss Clamping and Workholding Principles
    A. The role of clamps
    B. Tool forces
    C. Clamping forces
    D. Position of the clamps

VI. Discuss Types of Clamps
    A. Strap clamps
    B. Screw clamps
    C. Swing and hook clamps
    D. Edge clamps
    E. Wedge clamps
    F. Cam-action clamps
    G. Toggle-action clamps
    H. Power clamping (general discussion)

VII. Discuss Basic Construction Principles
    A. Tool bodies
    B. Blocks
    C. Bushings
    D. Fastening devices

Practical Application:

Students should be shown actual jigs and fixtures with special attention on the design. During each phase of instruction or topic, emphasis should be placed on that particular area of the tool. If possible, demonstrations of various types of each phase would be helpful.

Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-I3) which is an introduction to industrial dies.

TLD-I2-HO
Utilize Concepts of Jig and Fixture Design
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:
a. Identify basic components of jigs and fixtures;
b. Discuss supporting and locating principles;
c. Discuss clamping and workholding principles; and,
d. Discuss basic construction principles.

Module Outline:

I. Generally Discuss the Following Components of Jigs and Fixtures
  A. Tool bodies and plates (or bases)
  B. Locators
  C. Clamping or locking devices
  D. Bushings or guides
  E. Supports
  F. Keys
  G. Feet or legs
II. Define and Discuss Supporting and Locating Principles
  A. Referencing
  B. Repeatability
  C. Locator position
  D. Tool tolerance (relative to part tolerance)
  E. Foolproofing
  F. The twelve planes of movement ("degrees of freedom")
  G. The three forms of location: plane, concentric, and radial
  H. External and internal locating
III. Discuss the Primary Types of Supports
  A. Solid
  B. Adjustable
  C. Equalizing
IV. Discuss Locator Types
  A. Locating pins
  B. Nesting locators
  C. Vee locators
  D. Fixed-stop locators
  E. Adjustable locators
  F. Sight locators
  G. Spring-loaded devices
V. Discuss Clamping and Workholding Principles

    - A. The role of clamps
    - B. Tool forces
    - C. Clamping forces
    - D. Position of the clamps
- VI. Discuss Types of Clamps
    - A. Strap clamps
    - B. Screw clamps
    - C. Swing and hook clamps
    - D. Edge clamps
    - E. Wedge clamps
    - F. Cam-action clamps
    - G. Toggle-action clamps
    - H. Power clamping (general discussion)
- VII. Discuss Basic Construction Principles
    - A. Tool bodies
    - B. Blocks
    - C. Bushings
    - D. Fastening devices

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and,
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

Name______________________________ Date______________________

TLD-I2
Utilize Concepts of Jig and Fixture Design
Self-Assessment

1. List and define the components of jigs and fixtures.

____

____

____

2. List and define the primary types of supports.

____

____

____

3. List 5 types of locators.

____

____

____

____

____

4. List 5 types of clamps.

____

____

____

____

____

5. Identify the three forms of location.

____

____

____

6. Positioning the work with respect to the cutter or other tool is called ________________.

   a. Proper positioning
   b. Foolproofing
   c. Locating the work
   d. Referencing

7. As a general rule, what percentage of the part tolerance should the tool tolerance be? _____________
   a. 100
   b. 75-100
   c. 20-50
   d. 0-25

8. The feature of location that permits the parts to be made within their stated tolerances, part after part, throughout the production run is ___________.
   a. Referencing
   b. Repeatability
   c. Accuracy
   d. Precision

9. The major concerns in locating a part are __________________:
   a. Position of locators and locational tolerances
   b. Foolproofing the location and avoiding duplicate location
   c. All of the above
   d. None of the above

10. Locating a part by a single center hole will restrict ___________ planes of movement with a single locator. By positioning a second locator in another hole in the part, a total of __________ planes of movement are restricted.
    a. 9 and 11
    b. 9 and 10
    c. 7 and 11
    d. 7 and 10

11. The function of a clamp is to hold the part against the ___________ during the machining cycle.
    a. Locators
    b. Mounting plate
    c. Tool body
    d. Cutting tool

12. A properly designed tool __________________:
    a. Can use cutting forces to aid in holding the workpiece against the locators
    b. Will utilize large amounts of clamping pressure
    c. Will have clamps that hold all of the tool thrust
    d. Will not need clamps

13. Which of the following is not a condition of a clamp? (Which is not true?) ____________

a. Clamps must be strong enough to hold the part and resist movement.
b. Clamps must not damage or deform the part.
c. Clamps must be flexible enough to allow "growth" of the part during machining
d. None of the above. They are all true.

14. When clamping a single part using a strap clamp, the fastener should be positioned ________________:
a. In the center of the strap to apply equal pressure at both ends of the clamp.
b. 1/3 of the strap length from the part and 2/3 from the heel support.
c. 1/3 of the strap length from the heel support and 2/3 from the part.
d. Between the fulcrum and the part.

15. The main disadvantage of welded tool bodies is ________________:
a. Very low strength and rigidity.
b. Longer lead times than built-up tool bodies.
c. Added cost of paint and finishing.
d. Added cost of secondary machining.

16. Which of the following best describes the dimensions of an ANSI P-20-16-1250 drill bushing? ______________
a. .200" O.D. X .125" I.D. X .160" long
b. 20/32" O.D. X .125" I.D. X 16/16" long
c. 20mm O.D. X 16mm long X 125mm I.D.
d. 5/16" O.D. X 1" long X .125" I.D.

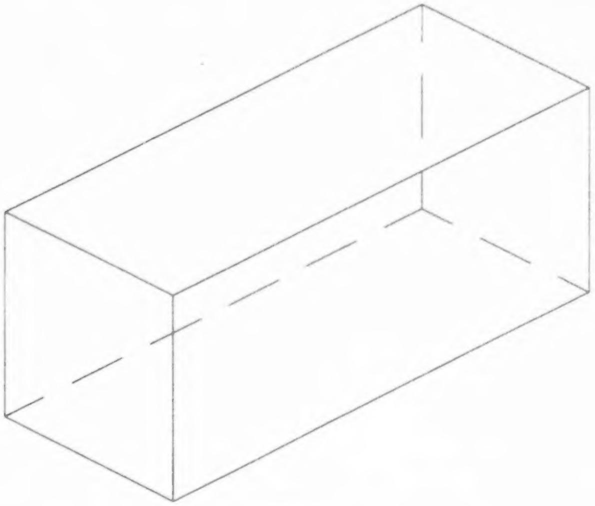
17. When determining the appropriate length and placement of drill bushings, which of the following is true? ____________________

a. The end of the bushing should touch the work for maximum effectiveness.
b. A clearance of one to one and a half times the tool diameter is sufficient for chip clearance.
c. If the bushing is too far away from the work, the bushings wear rapidly.
d. For extreme accuracy, the bushings should be placed as far away from the work as possible.

18. When more than one operation is performed at a single location, such as drilling and reaming, which type bushings should be used? ____________
   a. Renewable
   b. Slip-renewable
   c. Fixed-renewable
   d. Head-type press fit

19. For holes that are close together, thin wall bushings can be used. What other method is used? ________________
   a. Grind flats on adjacent bushings
   b. Reposition the part within the jig
   c. Only install one bushing but use a multiple spindle drill
   d. Do not drill the other hole. It is probably not needed anyway.

20. Draw and label each direction (plane) of movement in the following sketch. Be sure to indicate the X, Y, and Z axes.



TOOL & DIE and EDM SERIES

MASTER Technical Module No. TLD-I3

Subject: **Tool & Die and EDM** **Time: 6 Hrs.**

Duty: **Perform Tool and Die Making Operations**
Task: Demonstrate Understanding of Different Types of Industrial Dies

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Objective(s):

Upon completion of this unit the student will be able to:

a. Describe the operation of blanking or piercing dies;
b. Describe the operation of bending or forming dies;
c. Describe the operation of compound dies;
d. Describe the operation of progressive dies;
e. Describe the operation of draw dies;
f. Describe the operation of compression dies; and,
g. Describe the operation of combination dies.

Instructional Materials:

MASTER Handout (TLD-I3-HO)
MASTER Laboratory Aid (TLD-I3-LA)
MASTER Self-Assessment

References:

Basic Diemaking, D. Eugene Ostergaard, McGraw-Hill, Latest Edition
Die Design Fundamentals, J. R. Paquin and R. E. Crowley, Industrial Press, Latest Edition
Instructor's Guide, Basic Diemaking, D. Eugene Ostergaard, McGraw-Hill, Latest Edition
Advanced Diemaking, D. Eugene Ostergaard, National Tooling & Machining Association, McGraw-Hill, Latest Edition
Fundamentals of Pressworking, David A. Smith, Society of Manufacturing Engineers, Latest Edition
Progressive Dies: Principles and Practices of Design and Construction, Donald A. Peterson ed., Society of Manufacturing Engineers, Latest Edition
Tool Design, Donaldson, Goold, and LeCain, McGraw-Hill, Latest Edition
Die Design Handbook, Society of Manufacturing Engineers, McGraw-Hill, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:

TLD-A1 through TLD-A6	"Practice Safety"
TLD-B1 through TLD-B5	"Apply Mathematical Concepts"
TLD-C1	"Interpret and Understand Basic Layout/Types of Drawings"
TLD-C2	"Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances"
TLD-C3	"Use and Apply Geometric Dimensioning and Tolerancing (GD&T)"
TLD-C4	"Demonstrate Traditional Mechanical Drafting and Sketching Techniques"
TLD-D1 through TLD-D3	"Demonstrate Knowledge of Manufacturing Materials"
TLD-E1 through TLD-E6	"Measure/Inspect"
TLD-F1 through TLD-F10	"Demonstrate Knowledge of Manufacturing Processes"
TLD-I1	"Discuss Basic Types and Functions of Jigs and Fixtures"
TLD-I2	"Utilize Concepts of Jig and Fixture Design"

Introduction:

Although the lowly punch press seldom draws attention like the more modern automated processes, few areas of tooling are more fascinating and challenging. Because press technology allows efficient and economic production of such a wide range of products, the tooling must be just as diverse. Several operations can be performed simultaneously to produce a complex and detailed part with each machine cycle. In many cases, a press die performs tasks in only a couple of seconds that would employ several machinist for several hours to accomplish the same feat. From simple piercing to blanking, from drawing to coining, manufacturers have come to rely heavily on the consistency and efficiency of stamping their products.

Presentation Outline:

I. Describe the Operation of Cutting Dies
  A. Piercing dies
  B. Notching and slotting dies
  C. Horn-type (mandrel) cutting dies
  D. Blanking dies
  E. Trimming and shaving dies
  F. Cutoff dies
  G. Broaching dies
II. Describe Operation of Bending and Forming Dies
  A. V-dies

  - B. U-dies
  - C. Radius dies
  - D. Offset dies
  - E. Gooseneck dies
  - F. Miscellaneous dies (Curling, bulging, beading, etc.)
- III. Describe Operation of Compound Dies
  - A. Blank-and-pierce dies
  - B. Blank, pierce, and notch dies
  - C. Trim-and-pierce dies
  - D. Shave-and-pierce dies
  - E. Broach, cutoff, and pierce dies
- IV. Describe Operation of Draw Dies
- V. Describe Operation of Compression Dies
  - A. Sizing dies
  - B. Swaging (swedging) dies
  - C. Coining and embossing dies
  - D. Extruding dies
- VI. Describe Operation of Combination Dies
  - A. Cutoff-and-form dies
  - B. Lance-and-form dies
  - C. Cutoff, form, and pierce dies
  - D. Blank, draw, form, and pierce dies
  - E. Pierce, blank, lance, and emboss dies
  - F. Cutoff, form, and curl dies
  - G. Blank and draw dies
- VII. Describe Operation of Progressive Dies

Practical Application:

Students should be shown examples of as many types of the above dies as possible along with actual parts and operations performed. If feasible, a demonstration would be helpful as well.

Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-I4) dealing with utilizing basic die theory.

TLD-I3-HO
Demonstrate Understanding of Different Types of Industrial Dies
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Describe the operation of blanking or piercing dies;
b. Describe the operation of bending or forming dies;
c. Describe the operation of compound dies;
d. Describe the operation of progressive dies;
e. Describe the operation of draw dies;
f. Describe the operation of compression dies; and,
g. Describe the operation of combination dies.

Module Outline:

I. Describe the Operation of Cutting Dies
  A. Piercing dies
  B. Notching and slotting dies
  C. Horn-type (mandrel) cutting dies
  D. Blanking dies
  E. Trimming and shaving dies
  F. Cutoff dies
  G. Broaching dies
II. Describe Operation of Bending and Forming Dies
  A. V-dies
  B. U-dies
  C. Radius dies
  D. Offset dies
  E. Gooseneck dies
  F. Miscellaneous dies (Curling, bulging, beading, etc.)
III. Describe Operation of Compound Dies
  A. Blank-and-pierce dies
  B. Blank, pierce, and notch dies
  C. Trim-and-pierce dies
  D. Shave-and-pierce dies
  E. Broach, cutoff, and pierce dies
IV. Describe Operation of Draw Dies
V. Describe Operation of Compression Dies
  A. Sizing dies
  B. Swaging (swedging) dies
  C. Coining and embossing dies
  D. Extruding dies

VI. Describe Operation of Combination Dies
    A. Cutoff-and-form dies
    B. Lance-and-form dies
    C. Cutoff, form, and pierce dies
    D. Blank, draw, form, and pierce dies
    E. Pierce, blank, lance, and emboss dies
    F. Cutoff, form, and curl dies
    G. Blank and draw dies
VII. Describe Operation of Progressive Dies

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and,
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

Name____________________________ Date_____________________

TLD-I3
Demonstrate Understanding of Different Types of Industrial Dies
Self-Assessment

1. List and explain four types of cutting performed by dies.

2. List and explain four types of bending and forming dies.

3. Identify and define four types of operations performed by compression dies.

4. Distinguish between *compound* and *combination* dies.

5. Distinguish between draw and compression dies.

6. A die which cuts out a slug (which is usually scrap) in sheet or plate material is called a _____________ die.
   - a. Perforating
   - b. Piercing
   - c. Blanking
   - d. Slug

7. A secondary shearing or cutting operation in which the surface of a previously cut edge is finished or smoothed is called ____________.
   a. Finishing
   b. Smoothing
   c. Shearing
   d. Shaving

8. A die used to cut or shear a piece out of stock to a predetermined contour is a __________ die.
   a. Blanking
   b. Cutoff
   c. Cutting
   d. Bulging

9. A die which permanently deforms sheet or strip metal along a straight axis is called a ____________ die.
   a. Forming
   b. Dinking
   c. Parallel
   d. Bending

10. A die in which the shape of the punch and die is directly reproduced in the metal with little or no metal flow is called a __________ die.
   a. Forming
   b. Dinking
   c. Parallel
   d. Bending

11. If a return flange is required on a part, you would want to use a/an ________ die.
   a. Return
   b. Flange
   c. Offset
   d. Gooseneck

12. A blank-and-pierce die is an example of a ___________ die.
   a. Compound
   b. Compression
   c. Combination
   d. Dual-purpose

13. Press tools in which a cutting operation is combined with a shaping or deforming operation are called ___________ dies.
    a. Compound
    b. Compression
    c. Combination
    d. Dual-purpose

14. A process in which a punch causes flat metal to flow into a die cavity to assume the shape of a seamless hollow vessel is called __________.
    a. Flowing
    b. Drawing
    c. Molding
    d. Magic

15. ___________ operations compress and force metal to flow plastically through a shaped die orifice.
    a. Sizing
    b. Extruding
    c. Swaging
    d. Compressing

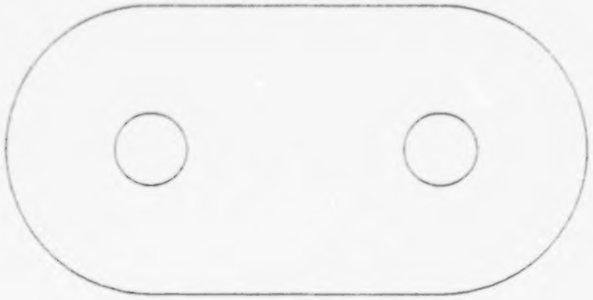
16. Coining is _____________:
    a. Inventing a phrase
    b. Forming an edge of circular cross section along a sheet
    c. Stamping a design into a metal blank without affecting the part dimensionally
    d. A squeezing operation in which all surfaces of the work are confined or restrained

17. A progressive die is so named because _________________:
    a. It is only one die in a progressive line
    b. The punches in the die progressively increase in size
    c. The work progresses through two or more stations in the die
    d. The technology employed is so much more progressive than earlier dies

18. An open-frame press for bending, cutting, and forming (usually handling long work in strips) is called a ____________.
    a. Press-brake
    b. Hydraulic press
    c. Triple-action press
    d. Punch press

19. U-dies are so named because _________________:
   a. They can only be operated on a U-type press.
   b. They were first invented and used by Irkslov Uosablol.
   c. The bending operations produced in them bear a resemblance to the letter U.
   d. They are made for punching and forming channel iron which resembles the letter U.

20. The following part is 2" wide X 12GA X 4" long with (2) 1/2" holes. It is to be stamped from 12 GA X 2-1/2" wide coil steel. It would be made in a ____________ die.
   a. Combination
   b. Compound pierce and radius
   c. Compound blank and pierce
   d. Good



TOOL & DIE and EDM SERIES

MASTER Technical Module No. TLD-I4

Subject:	**Tool & Die and EDM**	**Time: 6 Hrs.**
Duty:	**Perform Tool and Die Making Operations**	
Task:	Utilize Basic Die Theory	

Objective(s):

Upon completion of this unit the student will be able to:
a. Discuss shearing action on metal (3 stages);
b. Explain notch, pierce, pilot, form, and cut-off stations;
c. Explain operation of die set to make piece part;
d. Explain spring back in form dies;
e. Explain bending action in V-form dies; and,
f. Explain coining in dies.

Instructional Materials:

MASTER Handout (TLD-I4-HO1)
MASTER Laboratory Aid (TLD-I4-LA)
MASTER Self-Assessment

References:

Basic Diemaking, D. Eugene Ostergaard, McGraw-Hill, Latest Edition
Die Design Fundamentals, J. R. Paquin and R. E. Crowley, Industrial Press, Latest Edition
Instructor's Guide, Basic Diemaking, D. Eugene Ostergaard, McGraw-Hill, Latest Edition
Advanced Diemaking, D. Eugene Ostergaard, National Tooling & Machining Association, McGraw-Hill, Latest Edition
Fundamentals of Pressworking, David A. Smith, Society of Manufacturing Engineers, Latest Edition
Progressive Dies: Principles and Practices of Design and Construction, Donald A. Peterson ed., Society of Manufacturing Engineers, Latest Edition
Tool Design, Donaldson, Goold, and LeCain, McGraw-Hill, Latest Edition
Die Design Handbook, Society of Manufacturing Engineers, McGraw-Hill, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:

TLD-A1 through TLD-A6	"Practice Safety"
TLD-B1 through TLD-B5	"Apply Mathematical Concepts"
TLD-C1	"Interpret and Understand Basic Layout/Types of Drawings"
TLD-C2	"Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances"
TLD-C3	"Use and Apply Geometric Dimensioning and Tolerancing (GD&T)"
TLD-C4	"Demonstrate Traditional Mechanical Drafting and Sketching Techniques"
TLD-D1 through TLD-D3	"Demonstrate Knowledge of Manufacturing Materials"
TLD-E1 through TLD-E6	"Measure/Inspect"
TLD-F1 through TLD-F10	"Demonstrate Knowledge of Manufacturing Processes"
TLD-I1	"Discuss Basic Types and Functions of Jigs and Fixtures"
TLD-I2	"Utilize Concepts of Jig and Fixture Design"
TLD-I3	"Demonstrate Understanding of Different Types of Industrial Dies"

Introduction:

Before a student can begin his/her journey toward learning how to build even the simplest dies, a fundamental understanding of the die's operation is required. The theory of die operation cannot (and should not) be adequately explained on the die blueprint. Often, problems encountered during the manufacture of a die could be avoided if the toolmaker understood the tool's function and operation.

Presentation Outline:

I. Explain Operation of Die Set to Make Piece Part
II. Discuss Critical Stages of Shearing Action on Metal
  A. Plastic deformation
  B. Penetration
  C. Fracture
III. Explain Cutting Operations
  A. Blanking
  B. Piercing
  C. Notching
  D. Lancing
  E. Cutting off and parting
  F. Trimming and Shaving

IV. Discuss Bending Stresses
  A. The neutral plane
  B. The elastic limit of materials
  C. Plastic deformation and flow
  D. Springback
  E. Bend allowance curve
V. Explain Bending and Forming Operations
  A. Bending
    1. V-bending
    2. U-bending
    3. L-bending
  B. Forming
    1. Solid forming
    2. Pad type forming
    3. Miscellaneous methods (bulging, curling, coining and embossing)
  C. Drawing

Practical Application:

Students should be shown demonstrations of die operations and given exercises to demonstrate material science concepts.

Evaluation and/or Verification:

Students should successfully complete the Practical Application above and the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-I5) dealing with utilizing the principles of die design.

TLD-I4-HO
Utilize Basic Die Theory
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Discuss shearing action on metal (3 stages);
b. Explain notch, pierce, pilot, form, and cut-off stations;
c. Explain operation of die set to make piece part;
d. Explain spring back in form dies;
e. Explain bending action in V-form dies; and,
f. Explain coining in dies.

Module Outline:

I. Explain Operation of Die Set to Make Piece Part
Ii. Discuss Critical Stages of Shearing Action on Metal
    A. Plastic deformation
    B. Penetration
    C. Fracture
III. Explain Cutting Operations
    A. Blanking
    B. Piercing
    C. Notching
    D. Lancing
    E. Cutting off and parting
    F. Trimming and Shaving
IV. Discuss Bending Stresses
    A. The neutral plane
    B. The elastic limit of materials
    C. Plastic deformation and flow
    D. Springback
    E. Bend allowance curve
V. Explain Bending and Forming Operations
    A. Bending
        1. V-bending
        2. U-bending
        3. L-bending
    B. Forming
        1. Solid forming
        2. Pad type forming
        3. Miscellaneous methods (bulging, curling, coining and embossing)
    C. Drawing

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and,
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

Name________________________ Date______________

TLD-I4
Utilize Basic Die Theory
Self-Assessment

1. List in order the critical stages of shearing action on metal.

   ____
   ____
   ____

2. Briefly explain the characteristic appearance of piece parts produced by blanking and/or shearing.

   ____
   ____
   ____

3. What is the general purpose of a blanking die?

   ____
   ____
   ____

4. Distinguish between bending and forming.

   ____
   ____
   ____

5. Identify the four phases of bending action in a U-bending die.

   ____
   ____
   ____
   ____

6. The process of removing the punch from the penetrated material is called __________.

   a. Withdrawal
   b. Punch reversal
   c. Stripping
   d. Wiping

7. The space between a side of the punch and the corresponding side of the die opening at the cut edge when the punch is entered in the die opening is called the ___________.
   a. Excessive clearance
   b. Cutting clearance
   c. Angular clearance
   d. Burr side

8. During bending, the inner surface tends to become shorter as force is applied and the outer surface tends to become longer. This suggest that the inside material is in ___________ and the outside material is in ___________.
   a. Distortion, stress
   b. Compression, tension
   c. Tension, compression
   d. Force, tension

9. The curved neutral plane of the bend area is called the ___________.
   a. Bend allowance
   b. Curved plane
   c. Bend radius
   d. Bend angle

10. The cutting out of various shapes from the *edge* of a strip, blank, or part is called ___________.
    a. Shaving
    b. Trimming
    c. Lancing
    d. Notching

11. Cutting along a line in the workpiece without producing a detached slug from the workpiece is called ___________.
    a. Shaving
    b. Trimming
    c. Lancing
    d. Notching

12. During bending, the axis between the outer and inner surfaces where the length remains constant and where bending is considered to take place is called the ___________.
    a. Neutral plane or axis
    b. Bend line
    c. Bend radius
    d. Bend axis

13. The extent to which metal tends to return to its original shape or position after undergoing a forming operation is called ____________.
    a. Strain
    b. Springback
    c. Plastic deformation
    d. Elasticity

14. During ____________, the line of bend is curved instead of straight and the metal is subjected to plastic flow or deformation.
    a. Forming
    b. Bending
    c. Drawing
    d. Bulging

15. Proper ____________ is necessary to the life of the die and the quality of the piece part. If it is excessive, the piece part is unacceptable; if it is insufficient, there is undue stress and wear on the cutting members of the tool.
    a. Punch relief
    b. Material oxidation
    c. Gaging
    d. Cutting clearance

TLD-I4
Utilize Basic Die Theory
Self-Assessment Answer Key

6. c

7. b

8. b

9. a

10. d

11. c

12. a

13. b

14. a

15. d

TOOL & DIE and EDM SERIES

MASTER Technical Module No. TLD-I5

Subject: **Tool & Die and EDM** **Time: 40 Hrs.**

Duty: **Perform Tool and Die Making Operations**
Task: Utilize Principles of Die Design

Objective(s):

Upon completion of this unit the student will be able to:

a. Identify components of die set;
b. Discuss materials of die components;
c. Calculate proper shut-height of die set;
d. Design stock strip layout;
e. Calculate blank length for developed parts;
f. Calculate cutting length of piece part;
g. Determine press tonnage requirements;
h. Calculate die progression;
i. Calculate stripping pressure;
j. Calculate slug clearance;
k. Calculate cutting clearance; and,
l. Calculate offset displacement.

Instructional Materials:

MASTER Handout (TLD-I5-HO)
MASTER Laboratory Aid (TLD-I5-LA)
MASTER Self-Assessment

References:

Basic Diemaking, D. Eugene Ostergaard, McGraw-Hill, Latest Edition
Die Design Fundamentals, J. R. Paquin and R. E. Crowley, Industrial Press, Latest Edition
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Fundamentals of Pressworking, David A. Smith, Society of Manufacturing Engineers, Latest Edition

Progressive Dies: Principles and Practices of Design and Construction, Donald A. Peterson ed., Society of Manufacturing Engineers, Latest Edition
Tool Design, Donaldson, Goold, and LeCain, McGraw-Hill, Latest Edition
Die Design Handbook, Society of Manufacturing Engineers, McGraw-Hill, Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:

TLD-A1 through TLD-A6	"Practice Safety"
TLD-B1 through TLD-B5	"Apply Mathematical Concepts"
TLD-C1	"Interpret and Understand Basic Layout/Types of Drawings"
TLD-C2	"Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances"
TLD-C3	"Use and Apply Geometric Dimensioning and Tolerancing (GD&T)"
TLD-C4	"Demonstrate Traditional Mechanical Drafting and Sketching Techniques"
TLD-D1 through TLD-D3	"Demonstrate Knowledge of Manufacturing Materials"
TLD-E1 through TLD-E6	"Measure/Inspect"
TLD-F1 through TLD-F10	"Demonstrate Knowledge of Manufacturing Processes"
TLD-I1	"Discuss Basic Types and Functions of Jigs and Fixtures"
TLD-I2	"Utilize Concepts of Jig and Fixture Design"
TLD-I3	"Demonstrate Understanding of Different Types of Industrial Dies"
TLD-I4	"Utilize Basic Die Theory"

Introduction:

Although toolmakers will typically be given a blueprint to build a die from, rarely does it contain all the information needed. Certain specifications and dimensions are absent to allow the toolmaker enough flexibility to ensure the die performs as required. Therefore, to build a functional die, toolmakers must be familiar with basic principles of die design and capable of making the required calculations as he/she progresses along.

Presentation Outline:

I. Identify Components of a Typical Die
  A. Die set
  B. Punch

- C. Punch plate or holder
- D. Die block
- E. Stripper
- F. Pilot
- G. Stock guide or back gage
- H. Stop
- I. Fasteners

II. Identify Components of a Typical Die Set
- A. Die shoe
- B. Guidepost
- C. Guidepost bushing
- D. Punch shoe
- E. Shank
- F. Flange and bolt slot

III. Discuss Stock Strip Design
- A. Determining feed direction
- B. Locating stations
- C. Using strip layouts for die design
- D. Calculation of die progression

IV. Discuss Shut Height of Die
- A. Definition
- B. Calculation
- C. Determining stop block length

V. Discuss Punch Design
- A. Types
- B. Shear
- C. Material

VI. Discuss Design of Punch Plates
- A. Material
- B. Mounting

VII. Discuss Die Block Design
- A. Cutting clearances
  - 1. Definition and importance
  - 2. Calculation
    - a. Type of cut
    - b. Type of material
  - 3. Angular clearance
- B. Material
- C. Mounting

VIII. Discuss Cutting Force and Blanking Tonnage
- A. Determining the cutting area and length
- B. Shear or tensile strength of materials
- C. Calculation

IX. Discuss Stripper Design
- A. Types

- B. Stripping force
  - 1. Relationship with blanking tonnage
  - 2. Calculation
  - 3. Spring tables
  - 4. Rule of thumb for stripping bolts
- C. Knockouts
- D. Material
- E. Mounting

X. Discuss Pilot Design
- A. Methods
- B. Length and nose contour
- C. Material

XI. Discuss Design of Stock Guides and Back Gages
- A. Types
- B. Material

XII. Discuss Fasteners and Hardware
- A. Types
- B. Spacing

Practical Application:

Students should be given exercises in component identification, component design, and the various calculations discussed above.

Evaluation and/or Verification:

Students should successfully complete the Practical Application above and the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-I6) dealing with performing tool and die repair.

TLD-I5-HO
Utilize Principles of Die Design
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Identify components of die set;
b. Discuss materials of die components;
c. Calculate proper shut-height of die set;
d. Design stock strip layout;
e. Calculate blank length for developed parts;
f. Calculate cutting length of piece part;
g. Determine press tonnage requirements;
h. Calculate die progression;
i. Calculate stripping pressure;
j. Calculate slug clearance;
k. Calculate cutting clearance; and,
l. Calculate offset displacement.

Module Outline:

I. Identify Components of a Typical Die
   A. Die set
   B. Punch
   C. Punch plate or holder
   D. Die block
   E. Stripper
   F. Pilot
   G. Stock guide or back gage
   H. Stop
   I. Fasteners
II. Identify Components of a Typical Die Set
   A. Die shoe
   B. Guidepost
   C. Guidepost bushing
   D. Punch shoe
   E. Shank
   F. Flange and bolt slot
III. Discuss Stock Strip Design
   A. Determining feed direction
   B. Locating stations
   C. Using strip layouts for die design
   D. Calculation of die progression

IV. Discuss Shut Height of Die
  A. Definition
  B. Calculation
  C. Determining stop block length
V. Discuss Punch Design
  A. Types
  B. Shear
  C. Material
VI. Discuss Design of Punch Plates
  A. Material
  B. Mounting
VII. Discuss Die Block Design
  A. Cutting clearances
    1. Definition and importance
    2. Calculation
      a. Type of cut
      b. Type of material
    3. Angular clearance
  B. Material
  C. Mounting
VIII. Discuss Cutting Force and Blanking Tonnage
  A. Determining the cutting area and length
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IX. Discuss Stripper Design
  A. Types
  B. Stripping force
    1. Relationship with blanking tonnage
    2. Calculation
    3. Spring tables
    4. Rule of thumb for stripping bolts
  C. Knockouts
  D. Material
  E. Mounting
X. Discuss Pilot Design
  A. Methods
  B. Length and nose contour
  C. Material
XI. Discuss Design of Stock Guides and Back Gages
  A. Types
  B. Material
XII. Discuss Fasteners and Hardware
  A. Types
  B. Spacing

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and,
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

Name______________________________ Date________________

TLD-I5
Utilize Principles of Die Design
Self-Assessment

1. List the components of a typical die.

____
____
____

2. List the components of a typical die set.

____
____
____

3. Explain what is meant by "shear" when referring to punch shape. What is its purpose?

____
____
____

4. Explain the "rule of thumb" for stripper bolts.

____
____
____

5. Explain the use of dowel pins in die making.

____
____
____

6. The distance the stock must be fed is the ___________.
   a. Advance
   b. Feed
   c. Projection
   d. Cycle

7. What is the most important single factor in determining the relationship of a blank or piece part to the stock strip? ____________
   a. Length-to-width ratio
   b. Contour finish requirements
   c. Grain direction
   d. Nestability

8. Calculate the shut-height of a die with the following component dimensions:

Top shoe	1-1/2"
Bottom shoe	2"
Die block	1-1/2"
Punch length	2-1/2"
Backing plate	1/4"
Punch entry	1/8"

The shut height of this die is ____________; the stop block length is ____________.

a. 7-3/4; 4-1/4
b. 7-5/8; 4-1/8
c. 7-5/8; 7-3/4
d. 3-1/2; 4-1/4

9. Of the two major punch groups, which one requires another component, such as a punch plate, to locate and position them? ____________

a. Cutting punches
b. Segregated punches
c. Integrated punches
d. Hybrid punches

10. Calculate the cutting force required to punch a 0.50" (12.7 mm) diameter hole in 20 gage (0.038") mild steel (shear strength of 25 tons) using the formula *F=SLT*.

a. 0.5 tons
b. 0.75 tons
c. 1.5 tons
d. 15 tons

11. Calculate the amount of clearance and die opening for a rectangle punch with the following dimensions: 2.032" X 2.187" with .125 corner radii. Use 6 ga (.194) mild steel with a shear strength of 25 tons and required clearance of 5% per side.

a. .010" per side clearance; 2.042" X 2.197" die opening
b. .02" per side clearance; 2.072" X 2.227" die opening
c. .02" total clearance; 2.032" X 2.187" die opening
d. .01" per side clearance; 2.052" X 2.207" die opening

12. A good general practice in calculating angular clearance for sidewalls of the die opening is ______________:

a. 2 degrees per side
b. 1/4 to 3/4 degrees per side
c. 0.002" per in. per side
d. 1/8 degrees per side

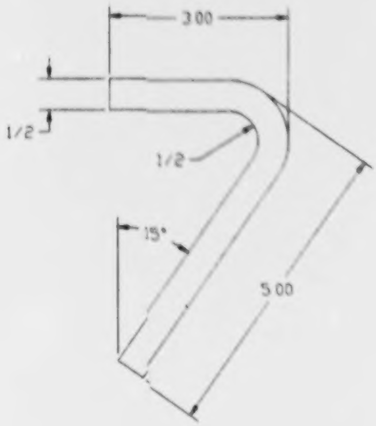
13. Calculate the stripping force required for the punch operation in question #11.
   a. 40 tons
   b. 41 tons
   c. 2 tons
   d. 8.2 tons

14. Strippers can be classified into two categories: ________________.
   a. Fixed and traveling
   b. Box and spring
   c. Hardened and soft
   d. Segregated and integrated

15. To ensure accuracy, the pilot for a .500" diameter punch piercing 16 ga. (0.0625") material would be ________________:
   a. 0.500" diameter
   b. 0.4375" diameter
   c. 0.4982" diameter
   d. Not enough information given

16. What material should gages be made of ? ____________________
   a. Cold-rolled steed
   b. Commercial gage stock
   c. Finished tool steel
   d. Either b or c

17. Calculate the flat blank length of the following piece part:
   a. 7.455
   b. 9.455
   c. 6.407
   d. 8.407



18. In the above problem, how far from the left end would the center of the V-form be?

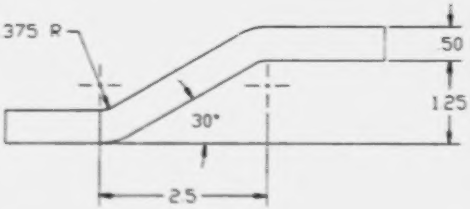
a. 3.7275
b. 3.2035
c. 2.7275
d. Cannot tell; not enough information

19. Calculate the offset displacement (delta) for the following part.
Formulas needed:

$P=(R+T/3)(.0349)$; $Q=2R+T$ $\quad Y_{min}=Q(1-\cos\alpha)$
$S=Y-Y_{min}$ $\quad L=P\,\alpha+S\csc\alpha$ $\quad \Delta=L-X$

Δ (Delta) =

a. 7.5
b. .232
c. 2.732
d. .0189



20. Which of the following die components would require heat treatment?

____

a. Die block
b. Pilot
c. Punch
d. All of the above

TLD-I5
Utilize Principles of Die Design
Self-Assessment Answer Key

6.	a
7.	c
8.	b
9.	c
10.	c
11.	d
12.	b
13.	c
14.	a
15.	c
16.	d
17.	a
18.	c
19.	b
20.	d

TLD-I6

TOOL & DIE and EDM SERIES

MASTER Technical Module No. TLD-I6

Subject: **Tool and Die and EDM** **Time: 40 Hrs.**

Duty: **Perform Tool and Die Making Operations**
Task: Perform Tool and Die Repair

Objective(s):

Upon completion of this unit the student will be able to:

a. Disassemble and assemble die set, jig, or fixture;
b. Visually inspect components for damage;
c. Determine method of repairing/sharpening;
d. Determine material for replacement parts; and,
e. Manufacture replacement parts.

Instructional Materials:

MASTER Handout (TLD-I6-HO)
MASTER Laboratory Aid (TLD-I6-LA)
MASTER Self-Assessment

References:

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Die Design Handbook, Society of Manufacturing Engineers, McGraw-Hill, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:

TLD-A1 through TLD-A6	"Practice Safety"
TLD-B1 through TLD-B5	"Apply Mathematical Concepts"
TLD-C1	"Interpret and Understand Basic Layout/Types of Drawings"
TLD-C2	"Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances"
TLD-C3	"Use and Apply Geometric Dimensioning and Tolerancing (GD&T)"
TLD-C4	"Demonstrate Traditional Mechanical Drafting and Sketching Techniques"
TLD-D1 through TLD-D3	"Demonstrate Knowledge of Manufacturing Materials"
TLD-E1 through TLD-E6	"Measure/Inspect"
TLD-F1 through TLD-F10	"Demonstrate Knowledge of Manufacturing Processes"
TLD-I1	"Discuss Basic Types and Functions of Jigs and Fixtures"
TLD-I2	"Utilize Concepts of Jig and Fixture Design"
TLD-I3	"Demonstrate Understanding of Different Types of Industrial Dies"
TLD-I4	"Utilize Basic Die Theory"
TLD-I5	"Utilize Principles of Die Design"

Introduction:

A necessary part of a Tool and Die Maker's job is to repair tooling. In fact, many smaller companies will buy their tooling from a tooling specialist and employ a tool maker to maintain it, making repair the primary responsibility. In larger companies, beginning tool makers might be assigned to the repair shop to gain experience before being given the responsibility of building a new tool. Many times, a tool maker has responsibility for both new and existing tooling. In either case, students should be given training in tooling repair in order to emphasize what must happen when the tooling wears. This will allow the tool maker to build in provisions for later maintenance, easing the potential problems for the repair.

Presentation Outline:

I. Discuss Safety in the Die Shop
  A. Proper die handling and transport
  B. Safety in the machine shop
II. Discuss Die Life
  A. Punch life
  B. Die block life

C. Characteristic cutting wear
D. Excessive wear

III. Discuss Inspection of Die Components
A. Identify and inspect component parts
B. Inspection of piece part

IV. Discuss Disassembly of Die
A. Removal and organization of component parts
B. Cleaning component parts

V. Discuss Repair of Damaged Parts
A. Sharpening
1. Amount of material to remove
2. Procedures and techniques
B. Replacement
1. Material
2. Construction

VI. Discuss Assembly of Die Set
A. Cleaning and deburring component parts
B. Mounting procedures
C. Checking clearances, depths, stop blocks, and shut-heights

VII. Documentation
A. Maintenance work orders
B. Die records
C. Preventive maintenance plan
D. Inspection tags

Practical Application:

Students should be given damaged dies and components to repair, rebuild, and mount.

Evaluation and/or Verification:

Students should successfully complete the Practical Application above and the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-I7) dealing with tool and die making skills.

TLD-I6-HO
Perform Tool and Die Repair
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:
- a. Disassemble and assemble die set, jig, or fixture;
- b. Visually inspect components for damage;
- c. Determine method of repairing/sharpening;
- d. Determine material for replacement parts; and,
- e. Manufacture replacement parts.

Module Outline:

- I. Discuss Safety in the Die Shop
    - A. Proper die handling and transport
    - B. Safety in the machine shop
- II. Discuss Die Life
    - A. Punch life
    - B. Die block life
    - C. Characteristic cutting wear
    - D. Excessive wear
- III. Discuss Inspection of Die Components
    - A. Identify and inspect component parts
    - B. Inspection of piece part
- IV. Discuss Disassembly of Die
    - A. Removal and organization of component parts
    - B. Cleaning component parts
- V. Discuss Repair of Damaged Parts
    - A. Sharpening
        - 1. Amount of material to remove
        - 2. Procedures and techniques
    - B. Replacement
        - 1. Material
        - 2. Construction
- VI. Discuss Assembly of Die Set
    - A. Cleaning and deburring component parts
    - B. Mounting procedures
    - C. Checking clearances, depths, stop blocks, and shut-heights
- VII. Documentation
    - A. Maintenance work orders
    - B. Die records
    - C. Preventive maintenance plan
    - D. Inspection tags

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    - a. No loose clothing, including ties;
    - b. Long hair properly stowed;
    - c. No jewelry;
    - d. Hard, closed-toe shoes;
    - e. Eye protection (safety glasses); and,
    - f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

Name______________________ Date________________

TLD-I6
Perform Tool and Die Repair
Self-Assessment

1. Discuss proper die handling, clamping, and transport.

2. Define die life.

3. Discuss characteristic cutting wear for normally functioning punches and dies.

4. Name 8 conditions which will cause abnormal wear.

5. Discuss how examining the piece part can identify problems with tooling.

6. Discuss sharpening of damaged or worn component parts, including how to determine the amount of material to remove and procedures for sharpening.

7. Discuss mounting procedures for a re-sharpened punch.

8. Identify how to check clearances, depths, stop block length and shut-height after resharpening or replacing components.

9. Discuss the need for a recording system to document history of dies.

10. Discuss the need for a preventive maintenance plan.

TOOL & DIE and EDM SERIES

MASTER Technical Module NO. TLD-I7

Subject: **Tool & Die and EDM** **Time: 40 Hrs.**

Duty: **Perform Tool and Die Making Operations**
Task: Demonstrate Tool and Die Making Skills

Objective(s):

Upon completion of this unit the student will be able to:
a. Identify component parts from tool blueprint
b. Determine material / purchased part requirements
c. Utilize tool making procedures to make and assemble component parts
d. Demonstrate mounting and operation of die set in press machine
e. Inspect operation of tooling and piece part for accuracy

Instructional Materials:

MASTER Handout (TLD-I7-HO)
MASTER Laboratory Aid (TLD-I7-LA)

References:

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Student Preparation:

Students should have previously completed the following Technical Modules:

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TLD-C2	**"Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances"**
TLD-C3	**"Use and Apply Geometric Dimensioning and Tolerancing (GD&T)"**
TLD-C4	**"Demonstrate Traditional Mechanical Drafting and Sketching Techniques"**
TLD-D1 through TLD-D3	**"Demonstrate Knowledge of Manufacturing Materials"**
TLD-E1 through TLD-E6	**"Measure/Inspect"**
TLD-F1 through TLD-F10	**"Demonstrate Knowledge of Manufacturing Processes"**
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TLD-I2	**"Utilize Concepts of Jig and Fixture Design"**
TLD-I3	**"Demonstrate Understanding of Different Types of Industrial Dies"**
TLD-I4	**"Utilize Basic Die Theory"**
TLD-I5	**"Utilize Principles of Die Design"**
TLD-I6	**"Perform Tool and Die Repair"**

Introduction:

For many years, a tool maker has been considered the most skilled worker in any given shop. To build tooling requires the most refined machining skills along with knowledge and expertise in tooling and dies. Tool makers often make subjective decisions that ultimately affect the success of the tooling and its ability to perform the necessary function. This "higher thinking" requires many years of experience and cannot simply be taught in a semester or two. Students can, however, be taught some of the fundamentals of tool making and given some introductory experience. This will equip them with skills which can be enhanced with actual industrial experience on their road to being a qualified tool and die maker.

Presentation Outline:

I. Handout the Tool Blueprint and Discuss
II. Discuss Acquisition of Material and Purchased Components
III. Discuss Tool Making Procedures
IV. Discuss Mounting Procedures
V. Discuss Mounting and Operation of Die Set in Press Machine

Practical Application:

Students should be given blueprints of tools and dies to be built.

Evaluation and/or Verification:

Students should successfully complete the Practical Application above and the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-J1) dealing with EDM fundamentals.

TLD-I7-HO
Demonstrate Tool and Die Making Skills
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Identify component parts from tool blueprint
b. Determine material / purchased part requirements
c. Utilize tool making procedures to make and assemble component parts
d. Demonstrate mounting and operation of die set in press machine
e. Inspect operation of tooling and piece part for accuracy

Module Outline:

I. Handout the Tool Blueprint and Discuss
II. Discuss Acquisition of Material and Purchased Components
III. Discuss Tool Making Procedures
IV. Discuss Mounting Procedures
V. Discuss Mounting and Operation of Die Set in Press Machine

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    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and,
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

TOOL AND DIE MAKER .... skilled workers who produce tools, dies, and special guiding and holding devices that are used in machining.

	Duties	Tasks												
A	Practice Safety	A-1 Follow safety manuals and all safety regulations/ requirements	A-2 Maintain safe equipment and machinery	A-3 Use safe operating procedures for hand and machine tools	A-4 Maintain a clean and safe work environment	A-5 Use safe material handling practices	A-6 Consult and apply MSDS for hazards of various materials							
B	Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Perform basic algebraic operations	B-3 Use basic geometric principles	B-4 Perform basic trigonometric functions	B-5 Use and apply Cartesian Coordinate System								
C	Interpret Engineering Drawings and Related Documents	C-1 Interpret and understand basic layout/types of drawings	C-2 Interpret, review, and apply blueprint notes, dimensions, and tolerances	C-3 Use and apply Geometric Dimensioning and Tolerancing (GD&T)	C-4 Demonstrate traditional mechanical drafting and sketching techniques	C-5 Understand and use quality systems								
D	Demonstrate Knowledge of Manufacturing Materials	D-1 Identify materials with desired properties	D-2 Identify materials and processes to produce a part	D-3 Discuss classification systems for metal										
E	Measure/ Inspect	E-1 Understand metrology terms	E-2 Select measurement tools	E-3 Measure with hand held instruments	E-4 Eliminate measurement variables	E-5 Measure/inspect using surface plate and accessories	E-6 Inspect using stationary equipment							
F	Demonstrate Knowledge of Manufacturing Processes	F-1 Discuss metal cutting and metal cutting tools	F-2 Operate metal saws	F-3 Operate drill presses and tooling	F-4 Operate engine and turret lathes and tooling	F-5 Operate vertical and horizontal mills and tooling	F-6 Operate precision grinders	F-7 Operate heat treating equipment and processes	F-8 Operate sheet metal equipment	F-9 Operate welding equipment and processes	F-10 Estimate time required/ cost to produce a part			
G	Use Computers	G-1 Use computer operating systems	G-2 Understand computer terminology	G-3 Use file management systems	G-4 Install and use software packages									
H	Perform CAD/ CAM and CNC Programming Tasks	H-1 Discuss fundamentals of CNC machines and controls	H-2 Program and operate CNC milling machine and machining center	H-3 Program and operate CNC lathe	H-4 Use Computer-Aided Drafting (CAD) system	H-5 Create 3-D solid models	H-6 Use Computer-Aided Manufacturing (CAM) system							
I	Perform Tool and Die Making Operations	I-1 Discuss basic types and functions of jigs and fixtures	I-2 Utilize concepts of jig and fixture design	I-3 Demonstrate understanding of different types of industrial dies	I-4 Utilize basic die theory	I-5 Utilize principles of die design	I-6 Perform tool and die repair	I-7 Demonstrate tool and die making skills						
J	Operate Electrical Discharge Machine (EDM)	J-1 Discuss fundamentals of EDM	J-2 Setup and operate conventional sinker EDM	J-3 Program, setup, and operate CNC sinker EDM and EDM drill	J-4 Program, setup, and operate CNC wire EDM									

TOOL & DIE and EDM SERIES

MASTER Technical Module No. TLD-J1

Subject: **Tool & Die and EDM** **Time: 4 Hrs.**

Duty: **Operate Electrical Discharge Machine (EDM)**
Task: Discuss Fundamentals of EDM

Objectives:

Upon completion of this unit the student will be able to:
- a. Explain the principles of Electrical Discharge Machining (EDM);
- b. Discuss the advantages, limitations, and applications of EDM;
- c. Discuss EDM safety;
- d. Name and state the purpose of the main components of the EDM process; and,
- e. Explain the types of EDM processes.

Instructional Materials:

MASTER Handout (TLD-J1-HO)
MASTER Laboratory Aid (TLD-J1-LA)
MASTER Self-Assessment

References:

Technology of Machine Tools, Steve Krar and Albert Check, Glencoe Publishing, Latest Edition
Machine Tool and Manufacturing Technology, Krar, Rapisarda, and Check, Delmar Publishers, Latest Edition
NTMA Machinist Training Program Module(s)
Instructor's Guide, Technology of Machine Tools, Amand, Krar, and Oswald, McGraw-Hill, Latest Edition
Workbook for Technology of Machine Tools, Amand, Krar, and Oswald, McGraw-Hill, Latest Edition
Machine Tool and Manufacturing Technology, Krar, Rapisarda, and Check, Delmar Publishing, Latest Edition
Wire EDM Handbook, Carl Sommer and Steve Sommer, Technical Advance Publishing Co., Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:

TLD-A1 through TLD-A6	"Practice Safety"
TLD-B1 through TLD-B5	"Apply Mathematical Concepts"
TLD-C1	"Interpret and Understand Basic Layout/Types of Drawings"
TLD-C2	"Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances"
TLD-C3	"Use and Apply Geometric Dimensioning and Tolerancing (GD&T)"
TLD-C4	"Demonstrate Traditional Mechanical Drafting and Sketching Techniques"
TLD-D1 through TLD-D3	"Demonstrate Knowledge of Manufacturing Materials"
TLD-E1 through TLD-E6	"Measure/Inspect"
TLD-F1 through TLD-F10	"Demonstrate Knowledge of Manufacturing Processes"
TLD-H1	"Discuss Fundamentals of CNC Machines and Controls"
TLD-H6	"Use Computer-Aided Manufacturing (CAM) System"

Introduction:

Electrical Discharge Machining (EDM) is now recognized, not only as a viable manufacturing solution, but as a required process and capability for almost every metal working company. Many time-consuming, tedious, and costly tasks have been replaced with EDM and, in some cases, otherwise impossible tasks have been made simple and routine. Tool and die makers have possibly realized the most benefits of EDM. It has virtually revolutionized the way tools and dies are made.

Presentation Outline:

I. Explain the Principles of Electrical Discharge Machining (EDM)
II. Discuss the Advantages, Limitations, and Applications of EDM
III. Discuss EDM Safety
IV. Name and State the Purpose of the Main Components of the EDM Process
    A. Electrode
        1. Characteristics
        2. Types
        3. Materials used
    B. Dielectric fluid
        1. Functions
        2. Characteristics
        3. Methods of circulating
    C. Servomechanism
    D. Power supply
    E. Machine Control Unit
V. Explain the Types of EDM Processes

A. Sinker (plunge or ram type) EDM
B. Traveling wire EDM

Practical Application:

Students should be given demonstration of and parts produced by EDM processes.

Evaluation and/or Verification:

Students should successfully complete the Practical Application above and the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-J2) dealing with setting up and operating conventional sinker EDM.

TLD-J1-HO
Discuss Fundamentals of EDM
Attachment 1: MASTER Handout

Objectives:

Upon completion of this unit the student will be able to:

a. Explain the principles of Electrical Discharge Machining (EDM);
b. Discuss the advantages, limitations, and applications of EDM;
c. Discuss EDM safety;
d. Name and state the purpose of the main components of the EDM process; and,
e. Explain the types of EDM processes.

Module Outline:

I. Explain the Principles of Electrical Discharge Machining (EDM)
II. Discuss the Advantages, Limitations, and Applications of EDM
III. Discuss EDM Safety
IV. Name and State the Purpose of the Main Components of the EDM Process
  A. Electrode
    1. Characteristics
    2. Types
    3. Materials used
  B. Dielectric fluid
    1. Functions
    2. Characteristics
    3. Methods of circulating
  C. Servomechanism
  D. Power supply
  E. Machine Control Unit
V. Explain the Types of EDM Processes
  A. Sinker (plunge or ram type) EDM
  B. Traveling wire EDM

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    - a. No loose clothing, including ties;
    - b. Long hair properly stowed;
    - c. No jewelry;
    - d. Hard, closed-toe shoes;
    - e. Eye protection (safety glasses); and,
    - f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

Name:________________________ Date:____________________

TLD-J1
Discuss Fundamentals of EDM
Self-Assessment

1. Define Electrical Discharge Machining(EDM).

2. List and explain five advantages of EDM.

3. List and explain five limitations of EDM.

4. List some applications of EDM.

5. List some safety precautions concerning EDM.

6. Name and state the purpose of the main components of an EDM.

7. What are the characteristics of a good electrode?

8. What materials are used for electrodes?

9. What are the functions of the dielectric?

10. What are the four methods of circulating the dielectric?

11. Explain the sinker EDM process.

12. Explain the wire EDM process.

13. Why must the workpiece be electrically conductive?

14. Give two advantages of the sinker EDM process over the wire EDM process.

15. Give two advantages of the wired EDM process over the sinker EDM process.

TOOL & DIE and EDM SERIES
MASTER Technical Module No. TLD-J2

Subject: **Tool & Die and EDM** **Time: 10 Hrs.**

Duty: **Operate Electrical Discharge Machine (EDM)**
Task: Setup and Operate Conventional Sinker EDM

Objective(s):

Upon completion of this unit the student will be able to:

a. Identify the components of the sinker EDM process;
b. Explain the terms and principles of the sinker EDM process;
c. Discuss electrode design and construction;
d. Practice safety with sinker EDM;
e. Set-up and operate sinker EDM; and,
f. Practice preventive maintenance measures for the sinker EDM

Instructional Materials:

MASTER Handout (TLD-J2-HO)
MASTER Laboratory Aid (TLD-J2-LA)
MASTER Self-Assessment

References:

Technology of Machine Tools, Steve Krar and Albert Check, Glencoe Publishing, Latest Edition
Machine Tool and Manufacturing Technology, Krar, Rapisarda, and Check, Delmar Publishers, Latest Edition
NTMA Machinist Training Program Module(s)
Instructor's Guide, Technology of Machine Tools, Amand, Krar, and Oswald, McGraw-Hill, Latest Edition
Workbook for Technology of Machine Tools, Amand, Krar, and Oswald, McGraw-Hill, Latest Edition
Machine Tool and Manufacturing Technology, Krar, Rapisarda, and Check, Delmar Publishing, Latest Edition
ELOX®: Fundamentals of EDM, Colt Industries, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
TLD-A1 through TLD-A6 "Practice Safety"

TLD-B1 through TLD-B5	"Apply Mathematical Concepts"
TLD-C1	"Interpret and Understand Basic Layout/Types of Drawings"
TLD-C2	"Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances"
TLD-C3	"Use and Apply Geometric Dimensioning and Tolerancing (GD&T)"
TLD-C4	"Demonstrate Traditional Mechanical Drafting and Sketching Techniques"
TLD-D1 through TLD-D3	"Demonstrate Knowledge of Manufacturing Materials"
TLD-E1 through TLD-E6	"Measure/Inspect"
TLD-F1 through TLD-F10	"Demonstrate Knowledge of Manufacturing Processes"
TLD-H1	"Discuss Fundamentals of CNC Machines and Controls"
TLD-H6	"Use Computer-Aided Manufacturing (CAM) System"
TLD-J1	"Discuss Fundamentals of EDM"

Introduction:

The die-sinking, or ram, EDM has a cutting tool (electrode) shaped to the form of the cavity, mounted in the ram of the machine. This machine tool was first used to remove broken taps from machined parts but was soon discovered as a useful and powerful asset in the manufacture of intricate parts from hardened material. While the latest technology includes the addition of CNC controllers to EDMs, several shops still use conventional types. Therefore, this module will introduce the concepts of sinker EDMing by looking at the conventional machine.

Presentation Outline:

I. Review the Components of the Sinker EDM Process
    A. Electrode
    B. Dielectric fluid
    C. Servomechanism
    D. Power supply
    E. Machine Control Unit
II. Explain the Principles and Terms of the Sinker EDM Process
    A. Amperage
    B. Frequency
    C. Voltage (gap and striking)
    D. Capacitance
    E. Polarity
    F. Ionization
    G. Overcut
    H. Swarf

  - I. Flushing
  - J. Surface Finish
  - K. Dither or vibration
  - L. Metal-removal rate
  - M. On-time
  - N. Off-time
- III. Discuss Electrode Design and Construction
  - A. Material selection
    - 1. Workpiece material
    - 2. Wear characteristics
    - 3. Machinability
    - 4. Cost
  - B. Accuracy
  - C. Surface finish
  - D. Coolant Flushing
- IV. Discuss Sinker EDM Safety
- V. Discuss Set-Up and Operation of EDM
  - A. Workpiece set-up
  - B. Tooling
  - C. Locating principles
  - D. Power supply controls
  - E. Machine tool controls
  - F. Cutting procedures and adjustments
  - G. Rough and finish cuts
- VI. Practice Preventive Maintenance Measures for the Sinker EDM

Practical Application:

Students should be given projects to complete using the sinker EDM process.

Evaluation and/or Verification:

Students should successfully complete the Practical Application above and the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-J3) dealing with programming, setting up, and operating the CNC sinker EDM and EDM drill.

TLD-J2-HO
Setup and Operate Conventional Sinker EDM
Attachment 1: **MASTER** Handout

Objective(s):

Upon completion of this unit the student will be able to:
a. Identify the components of the sinker EDM process;
b. Explain the terms and principles of the sinker EDM process;
c. Discuss electrode design and construction;
d. Practice safety with sinker EDM;
e. Set-up and operate sinker EDM; and,
f. Practice preventive maintenance measures for the sinker EDM

Module Outline:

I. Review the Components of the Sinker EDM Process
  A. Electrode
  B. Dielectric fluid
  C. Servomechanism
  D. Power supply
  E. Machine Control Unit
II. Explain the Principles and Terms of the Sinker EDM Process
  A. Amperage
  B. Frequency
  C. Voltage (gap and striking)
  D. Capacitance
  E. Polarity
  F. Ionization
  G. Overcut
  H. Swarf
  I. Flushing
  J. Surface Finish
  K. Dither or vibration
  L. Metal-removal rate
  M. On-time
  N. Off-time
III. Discuss Electrode Design and Construction
  A. Material selection
    1. Workpiece material
    2. Wear characteristics
    3. Machinability
    4. Cost
  B. Accuracy

- C. Surface finish
- D. Coolant Flushing

IV. Discuss Sinker EDM Safety

V. Discuss Set-Up and Operation of EDM
  - A. Workpiece set-up
  - B. Tooling
  - C. Locating principles
  - D. Power supply controls
  - E. Machine tool controls
  - F. Cutting procedures and adjustments
  - G. Rough and finish cuts

VI. Practice Preventive Maintenance Measures for the Sinker EDM

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and,
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

Name:______________________ Date:____________________

TLD-J2
Setup and Operate Conventional Sinker EDM
Self-Assessment

1. List and explain the function of the five main components of the EDM process.

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2. Explain the following terms or principles as they apply to the sinker EDM process:
   a. Amperage

   ____

   b. Frequency

   ____

   c. Voltage

   ____

   d. Overcut

   ____

   e. On-time

   ____

3. What factors are considered in determining the electrode material?

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4. Explain the use of a "stepped" electrode to rough and finish machine a through hole.

____

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5. Why does coolant flushing have to be considered when making the electrode?

6. What factors affect the surface finish?

7. What factors affect the metal removal rate?

8. Explain how to locate an electrode to the workpiece?

9. During operation, what should the operator continually monitor?

10. Discuss general safety precautions for sinker EDM.

TOOL & DIE and EDM SERIES

MASTER Technical Module No. TLD-J3

Subject: **Tool & Die and EDM** **Time: 20 Hrs.**

Duty: **Operate Electrical Discharge Machine (EDM)**
Task: Program, Setup, and Operate CNC Sinker EDM and EDM Drill

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Objective(s):

Upon completion of this unit the student will be able to:
- a. Review the components of the sinker EDM process;
- b. Discuss sinker EDM safety;
- c. Discuss applications and benefits of sinker EDM (specifically in Tool and Die);
- d. Discuss CNC programming of CNC sinker EDM;
- e. Discuss set-up and operation of CNC sinker EDM; and,
- f. Practice preventive maintenance measures for the CNC sinker EDM.

Instructional Materials:

MASTER Handout (TLD-J3-HO)
MASTER Laboratory Aid (TLD-J3-LA)
MASTER Self-Assessment

References:

Technology of Machine Tools, Steve Krar and Albert Check, Glencoe Publishing, Latest Edition
Machine Tool and Manufacturing Technology, Krar, Rapisarda, and Check, Delmar Publishers, Latest Edition
NTMA Machinist Training Program Module(s)
Instructor's Guide, Technology of Machine Tools, Amand, Krar, and Oswald, McGraw-Hill, Latest Edition
Workbook for Technology of Machine Tools, Amand, Krar, and Oswald, McGraw-Hill, Latest Edition
Machine Tool and Manufacturing Technology, Krar, Rapisarda, and Check, Delmar Publishing, Latest Edition
ELOX®: Fundamentals of EDM, Colt Industries, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:

TLD-A1 through TLD-A6	"Practice Safety"
TLD-B1 through TLD-B5	"Apply Mathematical Concepts"
TLD-C1	"Interpret and Understand Basic Layout/Types of Drawings"
TLD-C2	"Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances"
TLD-C3	"Use and Apply Geometric Dimensioning and Tolerancing (GD&T)"
TLD-C4	"Demonstrate Traditional Mechanical Drafting and Sketching Techniques"
TLD-D1 through TLD-D3	"Demonstrate Knowledge of Manufacturing Materials"
TLD-E1 through TLD-E6	"Measure/Inspect"
TLD-F1 through TLD-F10	"Demonstrate Knowledge of Manufacturing Processes"
TLD-H1	"Discuss Fundamentals of CNC Machines and Controls"
TLD-H6	"Use Computer-Aided Manufacturing (CAM) System"
TLD-J1	"Discuss Fundamentals of EDM"
TLD-J2	"Setup and Operate Conventional Sinker EDM"

Introduction:

The addition of Computer Numerical Control to EDM technology has increased its flexibility and usefulness tremendously. CNC sinker EDMs and EDM drills are now available to allow faster and more accurate machining with shaped electrodes. In many cases, otherwise impossible shapes can be machined using CNC technology.

Presentation Outline:

I. Review the Components of the Sinker EDM Process
    A. Electrode
    B. Dielectric fluid
    C. Servomechanism
    D. Power supply
    E. Machine Control Unit
II. Discuss Sinker EDM Safety
III. Discuss Applications and Benefits of Sinker EDM (specifically in Tool and Die)
IV. Discuss CNC Programming of CNC Sinker EDM
    A. Coordinate Words (X, Y, U, V, Z, I, J)
    B. Basic "G" codes
    C. Basic "M" codes
    D. Program origin point
    E. Simple programming
    F. CANNED cycles, subprograms, and macros

V. Discuss Set-Up and Operation of CNC Sinker EDM
  A. Workpiece set-up and requirements
  B. Electrode
  C. Tooling
  D. Locating principles
  E. Power supply controls
  F. Machine tool controls
  G. Program operation
    1. Manual Data Input (MDI)
    2. DNC and transfer
    3. Program edit
    4. Memory storage
  H. Cutting procedures and adjustments
  I. Starter and pilot holes
  J. Rough and finish cuts

VI. Practice Preventive Maintenance Measures for the CNC Sinker EDM

Practical Application:

Students should be given projects to complete using the sinker EDM process.

Evaluation and/or Verification:

Students should successfully complete the Practical Application above and the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-J4) dealing with programming, setting up, and operating the CNC wire EDM.

TLD-J3-HO
Program, Setup, and Operate CNC Sinker EDM and EDM Drill
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Review the components of the sinker EDM process;
b. Discuss sinker EDM safety;
c. Discuss applications and benefits of sinker EDM (specifically in Tool and Die);
d. Discuss CNC programming of CNC sinker EDM;
e. Discuss set-up and operation of CNC sinker EDM; and,
f. Practice preventive maintenance measures for the CNC sinker EDM.

Module Outline:

I. Review the Components of the Sinker EDM Process
    A. Electrode
    B. Dielectric fluid
    C. Servomechanism
    D. Power supply
    E. Machine Control Unit
II. Discuss Sinker EDM Safety
III. Discuss Applications and Benefits of Sinker EDM (specifically in Tool and Die)
IV. Discuss CNC Programming of CNC Sinker EDM
    A. Coordinate Words (X, Y, U, V, Z, I, J)
    B. Basic “G” codes
    C. Basic “M” codes
    D. Program origin point
    E. Simple programming
    F. CANNED cycles, subprograms, and macros
V. Discuss Set-Up and Operation of CNC Sinker EDM
    A. Workpiece set-up and requirements
    B. Electrode
    C. Tooling
    D. Locating principles
    E. Power supply controls
    F. Machine tool controls
    G. Program operation
        1. Manual Data Input (MDI)
        2. DNC and transfer
        3. Program edit

4. Memory storage

H. Cutting procedures and adjustments

I. Starter and pilot holes

J. Rough and finish cuts

VI. Practice Preventive Maintenance Measures for the CNC Sinker EDM

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and,
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

Name:______________________ Date:______________________

TLD-J3
Program, Setup, and Operate CNC Sinker EDM and EDM Drill
Self-Assessment

1. **List and explain the function of the five main components of the sinker EDM process.**

2. **Explain the following terms or principles as they apply to the sinker EDM process:**

3. **List five applications of a CNC sinker EDM.**

4. **List and explain three advantages of a CNC sinker EDM.**

5. **List five safety warnings concerning the CNC sinker EDM.**

6. **List and explain the steps to set-up and machine a .250" diameter hole through the center of a 5" cube. Include the CNC program.**

7. **Discuss preventive maintenance measures to observe on a CNC sinker EDM.**

TLD-J4

TOOL & DIE and EDM SERIES

MASTER Technical Module No. TLD-J4

Subject: **Tool & Die and EDM** **Time: 30 Hrs.**

Duty: **Operate Electrical Discharge Machine (EDM)**
Task: Program, Setup, and Operate CNC Wire EDM

Objective(s):

Upon completion of this unit the student will be able to:
a. Review the components of the CNC wire EDM process;
b. Explain the wire EDM process;
c. Identify the three types of Wire EDM;
d. Discuss applications and benefits of wire EDM (specifically in Tool and Die);
e. Explain the principles and terms of the wire EDM process;
f. Discuss wire EDM safety;
g. Discuss CNC programming of wire EDM;
h. Discuss set-up and operation of wire EDM; and,
i. Practice preventive maintenance measures for the wire EDM.

Instructional Materials:

MASTER Handout (TLD-J4-HO)
MASTER Laboratory Aid (TLD-J4-LA)
MASTER Self-Assessment

References:

Wire EDM Handbook, Carl Sommer and Steve Sommer, Technical Advance Publishing Co., Latest Edition
NTMA Machinist Training Program Module(s)
Technology of Machine Tools, Steve Krar and Albert Check, Glencoe Publishing, Latest Edition
Machine Tool and Manufacturing Technology, Krar, Rapisarda, and Check, Delmar Publishers, Latest Edition
Instructor's Guide, Technology of Machine Tools, Amand, Krar, and Oswald, McGraw-Hill, Latest Edition
Workbook for Technology of Machine Tools, Amand, Krar, and Oswald, McGraw-Hill, Latest Edition
Machine Tool and Manufacturing Technology, Krar, Rapisarda, and Check, Delmar Publishing, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:

TLD-A1 through TLD-A6	"Practice Safety"
TLD-B1 through TLD-B5	"Apply Mathematical Concepts"
TLD-C1	"Interpret and Understand Basic Layout/Types of Drawings"
TLD-C2	"Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances"
TLD-C3	"Use and Apply Geometric Dimensioning and Tolerancing (GD&T)"
TLD-C4	"Demonstrate Traditional Mechanical Drafting and Sketching Techniques"
TLD-D1 through TLD-D3	"Demonstrate Knowledge of Manufacturing Materials"
TLD-E1 through TLD-E6	"Measure/Inspect"
TLD-F1 through TLD-F10	"Demonstrate Knowledge of Manufacturing Processes"
TLD-H1	"Discuss Fundamentals of CNC Machines and Controls"
TLD-H6	"Use Computer-Aided Manufacturing (CAM) System"
TLD-J1	"Discuss Fundamentals of EDM"
TLD-J2	"Setup and Operate Conventional Sinker EDM"
TLD-J3	"Program, Setup, and Operate CNC Sinker EDM and EDM Drill"

Introduction:

A brochure published by the Society of Manufacturing Engineers states: "EDM can no longer be considered nontraditional machining." Several advances and improvements are then mentioned to justify the statement. With the emergence of CNC wire EDM technology, the EDM process has become one of the most utilized in the machine tool industry. Practically no tool and die shop can compete successfully without a wire EDM or, at least, access to one. Wire EDM has changed the methodology used in building dies with its ability to machine hardened parts. Tool and die students must have a foundation of knowledge pertaining to the EDM process.

Presentation Outline:

I. Review the Components of the CNC Wire EDM Process
    A. Electrode
    B. Dielectric fluid
    C. Servomechanism
    D. Power supply
    E. Machine Control Unit
II. Explain the Wire EDM Process

- III. Identify the Three Types of Wire EDM
  - A. Two axis
  - B. Simultaneous four axis
  - C. Independent four axis
- IV. Discuss Applications and Benefits of Wire EDM (specifically in Tool and Die)
- V. Explain the Principles and Terms of the Wire EDM Process
  - A. Kerf
  - B. Overcut
  - C. On-time/Off-time
  - D. Flushing
  - E. Flow rate
  - F. Amperage
  - G. Voltage
  - H. Current
  - I. Polarity
  - J. Dielectric fluid resistivity
  - K. Wire tension
  - L. Wire feed
- VI. Discuss Wire EDM Safety
- VII. Discuss CNC Programming of Wire EDM
  - A. Coordinate words (X, Y, U, V, Z, I, J)
  - B. Basic "G" codes
  - C. Basic "M" codes
  - D. Program origin point
  - E. Simple two-axis programming
  - F. CANNED cycles, subprograms, and macros
  - G. Four-axis programming
- VIII. Discuss Set-Up and Operation of Wire EDM
  - A. Workpiece set-up and requirements
  - B. Electrode (wire)
  - C. Tooling
  - D. Locating principles
  - E. Power supply controls
  - F. Machine tool controls
  - G. Program operation
    - 1. Manual Data Input (MDI)
    - 2. DNC and transfer
    - 3. Program edit
    - 4. Memory storage
  - H. Cutting procedures and adjustments
  - I. Starter and pilot holes
  - J. Rough and finish cuts
- IX. Practice Preventive Maintenance Measures for the Wire EDM

Practical Application:

Students should be given projects to complete using the wire EDM.

Evaluation and/or Verification:

Students should successfully complete the Practical Application above and the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.

Next Lesson Assignment:

This completes the series of Tool & Die and EDM technical modules.

TLD-J4-HO
Program, Setup, and Operate CNC Wire EDM
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Review the components of the CNC wire EDM process;
b. Explain the wire EDM process;
c. Identify the three types of Wire EDM;
d. Discuss applications and benefits of wire EDM (specifically in Tool and Die);
e. Explain the principles and terms of the wire EDM process;
f. Discuss wire EDM safety;
g. Discuss CNC programming of wire EDM;
h. Discuss set-up and operation of wire EDM; and,
i. Practice preventive maintenance measures for the wire EDM.

Module Outline:

I. Review the Components of the CNC Wire EDM Process
   A. Electrode
   B. Dielectric fluid
   C. Servomechanism
   D. Power supply
   E. Machine Control Unit
II. Explain the Wire EDM Process
III. Identify the Three Types of Wire EDM
   A. Two axis
   B. Simultaneous four axis
   C. Independent four axis
IV. Discuss Applications and Benefits of Wire EDM (specifically in Tool and Die)
V. Explain the Principles and Terms of the Wire EDM Process
   A. Kerf
   B. Overcut
   C. On-time/Off-time
   D. Flushing
   E. Flow rate
   F. Amperage
   G. Voltage
   H. Current
   I. Polarity
   J. Dielectric fluid resistivity
   K. Wire tension

    - L. Wire feed
- VI. Discuss Wire EDM Safety
- VII. Discuss CNC Programming of Wire EDM
    - A. Coordinate words (X, Y, U, V, Z, I, J)
    - B. Basic "G" codes
    - C. Basic "M" codes
    - D. Program origin point
    - E. Simple two-axis programming
    - F. CANNED cycles, subprograms, and macros
    - G. Four-axis programming
- VIII. Discuss Set-Up and Operation of Wire EDM
    - A. Workpiece set-up and requirements
    - B. Electrode (wire)
    - C. Tooling
    - D. Locating principles
    - E. Power supply controls
    - F. Machine tool controls
    - G. Program operation
        - 1. Manual Data Input (MDI)
        - 2. DNC and transfer
        - 3. Program edit
        - 4. Memory storage
    - H. Cutting procedures and adjustments
    - I. Starter and pilot holes
    - J. Rough and finish cuts
- IX. Practice Preventive Maintenance Measures for the Wire EDM

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and,
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

Name:____________________ Date:____________________

TLD-J4
Program, Setup, and Operate CNC Wire EDM
Self-Assessment

1. List and explain the main components of a CNC wire EDM.

____

____

____

2. Briefly describe how wire EDM works.

____

____

____

3. Explain what is meant by "super precision band saw".

____

____

____

4. List and explain the three types of wire EDM.

____

____

____

5. List five applications of wire EDM.

____

____

____

____

____

6. List and explain three advantages or benefits of wire EDM.

____

____

____

7. Explain the following terms or principles as they apply to the wire EDM process:
   - a. Amperage

     ____

   - b. Ke

     ____

c. Voltage

d. Overcut

e. On-time

f. Wire Tension

8. List five safety warnings concerning wire EDM.

9. List and explain the steps to set-up and machine a 5" square part with a 2" diameter hole on a wire EDM, including the CNC program.

10. Discuss preventive maintenance measures to observe on a wire EDM.

MACHINE TOOL ADVANCED SKILLS TECHNOLOGY EDUCATIONAL RESOURCES

MASTER

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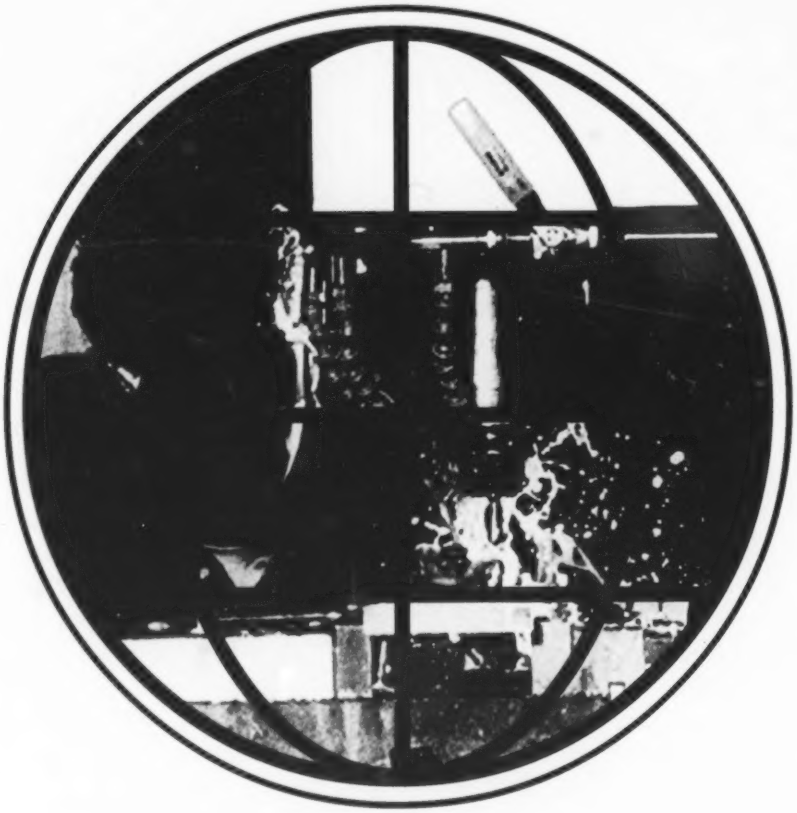
EDUCATIONAL RESOURCES
FOR THE
MACHINE TOOL INDUSTRY



Tool & Die and EDM Series
STUDENT LABORATORY MANUAL

347

Supported by the National Science Foundation's Advanced Technological Education Program

MASTER

MACHINE TOOL ADVANCED SKILLS TECHNOLOGY EDUCATIONAL RESOURCES

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EDUCATIONAL RESOURCES
FOR THE
MACHINE TOOL INDUSTRY

Tool & Die and EDM Series
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MASTER Consortia of Employers and Educators

MASTER has built upon the foundation which was laid by the Machine Tool Advanced Skills Technology (MAST) Program. The MAST Program was supported by the U.S. Department of Education - Office of Vocational and Adult Education. Without this prior support MASTER could not have reached the level of quality and quantity that is contained in these project deliverables.

MASTER DEVELOPMENT CENTERS

Augusta Technical Institute - Central Florida Community College - Itawamba Community College - Moraine Valley Community College - San Diego City College (CACT) - Springfield Technical Community College - Texas State Technical College

INDUSTRIES

AB Lasers - AIRCAP/MTD - ALCOA - American Saw - AMOCO Performance Products - Automatic Switch Company - Bell Helicopter - Bowen Tool - Brunner - Chrysler Corp. - Chrysler Technologies - Conveyor Plus - Darr Caterpillar - Davis Technologies - Delta International - Devon - D. J. Plastics - Eaton Leonard - EBTEC - Electro-Motive - Emergency One - Eureka - Foster Mold - GeoDiamond/Smith International - Greenfield Industries - Hunter Douglas - Industrial Laser - ITT Engineered Valve - Kaiser Aluminum - Krueger International. - Laser Fare - Laser Services - Lockheed Martin - McDonnell Douglas - Mercury Tool - NASSCO - NutraSweet - Rapistan DEMAG - Reed Tool - ROHR, International - Searle - Solar Turbine - Southwest Fabricators - Smith & Wesson - Standard Refrigeration - Super Sagless - Taylor Guitars - Tecumseh - Teledyne Ryan - Thermal Ceramics - Thomas Lighting - FMC, United Defense - United Technologies Hamilton Standard

COLLEGE AFFILIATES

Aiken Technical College - Bevil Center for Advanced Manufacturing Technology - Chicago Manufacturing Technology Extension Center - Great Lakes Manufacturing Technology Center - Indiana Vocational Technical College - Milwaukee Area Technical College - Okaloosa-Walton Community College - Piedmont Technical College - Pueblo Community College - Salt Lake Community College - Spokane Community College - Texas State Technical Colleges at Harlington, Marshall, Sweetwater

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Jet Propulsion Lab - Lawrence Livermore National Laboratory - L.B.J. Space Center (NASA) - Los Alamos Laboratory - Oak Ridge National Laboratory - Sandia National Laboratory - Several National Institute of Standards and Technology Centers (NIST) - Tank Automotive Research and Development Center (TARDEC) - Wright Laboratories

SECONDARY SCHOOLS

Aiken Career Center - Chicopee Comprehensive High School - Community High School (Moraine, IL) - Connally ISD - Consolidated High School - Evans High - Greenwood Vocational School - Hoover Sr. High - Killeen ISD - LaVega ISD - Lincoln Sr. High - Marlin ISD - Midway ISD - Moraine Area Career Center - Morse Sr. High - Point Lamar Sr. High -

Pontotoc Ridge Area Vocational Center - Putnam Vocational High School - San Diego Sr. High - Tupelo-Lee Vocational Center - Waco ISD - Westfield Vocational High School

ASSOCIATIONS

American Vocational Association (AVA) - Center for Occupational Research and Development (CORD) - CIM in Higher Education (CIMHE) - Heart of Texas Tech-Prep - Midwest (Michigan) Manufacturing Technology Center (MMTC) - National Coalition For Advanced Manufacturing (NACFAM) - National Coalition of Advanced Technology Centers (NCATC) - National Skills Standards Pilot Programs - National Tooling and Machining Association (NTMA) - New York Manufacturing Extension Partnership (NYMEP) - Precision Metalforming Association (PMA) - Society of Manufacturing Engineers (SME) - Southeast Manufacturing Technology Center (SMTC)

MASTER PROJECT EVALUATORS

Dr. James Hales, East Tennessee State University and William Ruxton, formerly with the National Tooling and Machine Association (NTMA)

NATIONAL ADVISORY COUNCIL MEMBERS

The National Advisory Council has provided input and guidance into the project since the beginning. Without their contributions, MASTER could not have been nearly as successful as it has been. Much appreciation and thanks go to each of the members of this committee from the project team.

Dr. Hugh Rogers-Dean of Technology-Central Florida Community College
Dr. Don Clark-Professor Emeritus-Texas A&M University
Dr. Don Edwards-Department of Management-Baylor University
Dr. Jon Botsford-Vice President for Technology-Pueblo Community College
Mr. Robert Swanson-Administrator of Human Resources-Bell Helicopter, TEXTRON
Mr. Jack Peck-Vice President of Manufacturing-Mercury Tool & Die
Mr. Don Hancock-Superintendent-Connally ISD

SPECIAL RECOGNITION

Dr. Hugh Rogers recognized the need for this project, developed the baseline concepts and methodology, and pulled together industrial and academic partners from across the nation into a solid consortium. Special thanks and singular congratulations go to Dr. Rogers for his extraordinary efforts in this endeavor.

Dr. Don Pierson served as the Principal Investigator for the first two years of MASTER. His input and guidance of the project during the formative years was of tremendous value to the project team. Special thanks and best wishes go to Dr. Pierson during his retirement and all his worldly travels.

All findings and deliverables resulting from MASTER are primarily based upon information provided by the above companies, schools and labs. We sincerely thank key personnel within these organizations for their commitment and dedication to this project. Including the national survey, more than 2,800 other companies and organizations participated in this project. We commend their efforts in our combined attempt to reach some common ground in precision manufacturing skills standards and curriculum development.

MASTER DEVELOPMENT CENTER, TUPELO, MS
Itawamba Community College
Tupelo Campus

David Cole, President
Itawamba Community College
Charles Chrestman, Dean
Career Education and Community Services
Don Benjamin, Associate Dean
Career Education

653 Eason Boulevard
Tupelo, MS 38801
College phone: 601/842-5621, fax: 601/680-8423

Manufacturing in Mississippi

Evolving from a previously agrarian economy, the region served by Itawamba Community College now contains a significant industrial base. Approximately 45% of employed adults in the surrounding area work in manufacturing, with the predominant industries including metal-working, machinery, paper products, rubber/plastics, electrical components, furniture, apparel, and wood products. About 35-40% of all manufacturing employees work in the furniture industry. After World War II, several major metal-working companies established branch plants in the Tupelo area, a trend that has continued into the 1990's. Between 1975 and 1980, pressures of competition and technology caused a number of these companies to reconsider their continued presence in northern Mississippi, spurring action by regional economic development organizations to preserve an employment and tax base essential to the community. Many of their economic development initiatives involved the community college, leading directly to the establishment of its Tool and Die Making Technology program and introduction of training in CAD, CNC, robotics, and lasers.

Itawamba Community College

Itawamba Community College (ICC) provides university transfer programs, associate degree career programs, non-credit customized industry training, and continuing education to a rural five-county area in northeast Mississippi. Of the local population of approximately 170,000 persons, 79% are white and 19% black; the student profile at the College roughly mirrors the racial composition of the general population, and a high percentage of students are from low-income households. The mission of the College includes the mandate to provide "educational services which contribute to the needs of new, expanding, or existing businesses and industries and to the training needs of the people." Accordingly, the College's instructional programs are designed with national trends and the needs of business and industry in mind, and the objective of all courses and training is to provide both students and companies with what they need to succeed. The main campus is in Fulton and the vocational-technical campus in Tupelo.

Development Team

- **Project Director:** Don Benjamin, Associate Dean of Career Education, served as program manager and academic coordinator for the MASTER project.
- **Site Coordinator**: Barry Emison was responsible for industrial assessment and skills validation, as well as development of skill standards and course/program materials for the Tool and Die Technology component of the MASTER project.
- **Subject Matter Experts**: Several college academic and technology instructors served as advisors for basic academic competencies, sharing responsibility with Mr. Emison for compiling data from industry surveys and interviews during the skill standards development process. Donald Taylor and Terry Kitchens, Tool and Die Technology Instructors, served as technical advisors for workplace competencies and developed course curricula and program materials. They also served as co-instructors and coordinators for the MASTER pilot program in Tool and Die Technology.

Introduction:
STUDENT LABORATORY MANUAL

Prior to the development of this Student Laboratory Manual, MASTER project staff visited over 150 companies, conducted interviews with over 500 expert workers, and analyzed data from a national survey involving over 2800 participating companies. These investigations led to the development of a series of Instructor Handbooks, with each being fully industry-driven and specific to one of the technologies shown below:

Advanced CNC and CAM
Automated Equipment Repair
Computer Aided Design & Drafting
Conventional Machining
Industrial Maintenance
Instrumentation
LASER Machining
Manufacturing Technology
Mold Making
Tool And Die
Welding

Each Instructor's Handbook contains a collection of Technical Training Modules which are built around a Competency Profile for the specific occupation. **The Competency Profile which is the basis for this Student Laboratory Manual may be found on the following page (and on each of the tab pages in this book).**

This Student Laboratory Manual has been developed as an learning aid for both the instructor and for the student, and is intended to be used in conjunction with the Instructor's Handbook.

This Student Laboratory Manual is arranged by Duty groupings (Duty A, Duty B, etc.) with learning modules available for each Task Box on the Competency Profile.

This Student Laboratory Manual is supplied with an accompanying Instructor's Handbook for use by the instructor.

Each module in the Instructor's Handbook has a corresponding learning module in the Student Laboratory Manual.

TOOL AND DIE MAKER .... skilled workers who produce tools, dies, and special guiding and holding devices that are used in machining.

	Duties	Tasks												
A	Practice Safety	A-1 Follow safety manuals and all safety regulations/ requirements	A-2 Maintain safe equipment and machinery	A-3 Use safe operating procedures for hand and machine tools	A-4 Maintain a clean and safe work environment	A-5 Use safe material handling practices	A-6 Consult and apply MSDS for hazards of various materials							
B	Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Perform basic algebraic operations	B-3 Use basic geometric principles	B-4 Perform basic trigonometric functions	B-5 Use and apply Cartesian Coordinate System								
C	Interpret Engineering Drawings and Related Documents	C-1 Interpret and understand basic layout/types of drawings	C-2 Interpret, review, and apply blueprint notes, dimensions, and tolerances	C-3 Use and apply Geometric Dimensioning and Tolerancing (GD&T)	C-4 Demonstrate traditional mechanical drafting and sketching techniques	C-5 Understand and use quality systems								
D	Demonstrate Knowledge of Manufacturing Materials	D-1 Identify materials with desired properties	D-2 Identify materials and processes to produce a part	D-3 Discuss classification systems for metal										
E	Measure/ Inspect	E-1 Understand metrology terms	E-2 Select measurement tools	E-3 Measure with hand held instruments	E-4 Eliminate measurement variables	E-5 Measure/inspect using surface plate and accessories	E-6 Inspect using stationary equipment							
F	Demonstrate Knowledge of Manufacturing Processes	F-1 Discuss metal cutting and metal cutting tools	F-2 Operate metal saws	F-3 Operate drill presses and tooling	F-4 Operate engine and turret lathes and tooling	F-5 Operate vertical and horizontal mills and tooling	F-6 Operate precision grinders	F-7 Operate heat treating equipment and processes	F-8 Operate sheet metal equipment	F-9 Operate welding equipment and processes	F-10 Estimate time required/ cost to produce a part			
G	Use Computers	G-1 Use computer operating systems	G-2 Understand computer terminology	G-3 Use file management systems	G-4 Install and use software packages									
H	Perform CAD/ CAM and CNC Programming Tasks	H-1 Discuss fundamentals of CNC machines and controls	H-2 Program and operate CNC milling machine and machining center	H-3 Program and operate CNC lathe	H-4 Use Computer-Aided Drafting (CAD) system	H-5 Create 3-D solid models	H-6 Use Computer-Aided Manufacturing (CAM) system							
I	Perform Tool and Die Making Operations	I-1 Discuss basic types and functions of jigs and fixtures	I-2 Utilize concepts of jig and fixture design	I-3 Demonstrate understanding of different types of industrial dies	I-4 Utilize basic die theory	I-5 Utilize principles of die design	I-6 Perform tool and die repair	I-7 Demonstrate tool and die making skills						
J	Operate Electrical Discharge Machine (EDM)	J-1 Discuss fundamentals of EDM	J-2 Setup and operate conventional sinker EDM	J-3 Program, setup, and operate CNC sinker EDM and EDM drill	J-4 Program, setup, and operate CNC wire EDM									

TLD PM8
[illegible]

TOOL AND DIE MAKER .... skilled workers who produce tools, dies, and special guiding and holding devices that are used in machining

	Duties	Tasks												
A	Practice Safety	A-1 Follow safety manuals and all safety regulations/ requirements	A-2 Maintain safe equipment and machinery	A-3 Use safe operating procedures for hand and machine tools	A-4 Maintain a clean and safe work environment	A-5 Use safe material handling practices	A-6 Consult and apply MSDS for hazards of various materials							
B	Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Perform basic algebraic operations	B-3 Use basic geometric principles	B-4 Perform basic trigonometric functions	B-5 Use and apply Cartesian Coordinate System								
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E	Measure/ Inspect	E-1 Understand metrology terms	E-2 Select measurement tools	E-3 Measure with hand held instruments	E-4 Eliminate measurement variables	E-5 Measure/inspect using surface plate and accessories	E-6 Inspect using stationary equipment							
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J	Operate Electrical Discharge Machine (EDM)	J-1 Discuss fundamentals of EDM	J-2 Setup and operate conventional sinker EDM	J-3 Program, setup, and operate CNC sinker EDM and EDM drill	J-4 Program, setup, and operate CNC wire EDM									

TLD PM8
[illegible]

TLD-A1-HO
Follow Safety Manuals and All Safety Regulations/Requirements
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:
a. Assume responsibility for the personal safety of oneself and others;
b. Develop a personal attitude towards safety;
c. Interpret safety manual directives;
d. Identify and control common machine shop hazards; and,
e. Comply with established company safety practices.

Module Outline:

I. Assume Responsibility for the Personal Safety of Oneself and Others
  A. Safety is a way of life not an option
  B. Always operate with alertness and safety foremost in mind
II. Develop a Personal Attitude Towards Safety
  A. The key to safety is individual safety
  B. Everyone must develop a safe attitude
  C. Each step of the operation must be carefully planned
III. Interpret Safety Manual Directives
  A. Read and understand safety manual
  B. Read machine operation instructions
IV. Comply with Established Safety Practices
  A. Personal safety
    1. Body: keep body out of line of tool edge
    2. Proper lifting technique
      a. Personal lifting
        1) Lift with the legs, not the back
        2) Proper physical position while lifting
        3) Proper clearance for carrying
        4) "Buddy system" for heavy lifting
      b. Equipment lifting
        1) Checking ratings for lifting devices
        2) Checking lifting points on lifted item
        3) Overhead clearance requirements
        4) Static lifting devices (slings, jack stands) should be used instead of moving lifting devices (jacks or forklifts) for actually holding heavy items up while working on them
  B. Eyes: always wear safety glasses
  C. Head: keep long hair up; wear hard hat whenever required

- D. Ears: wear protection to prevent damage from noise
- E. Jewelry: no rings, watches, bracelets, necklaces (they can get caught in machinery and they are conductors of electricity)
- F. Clothing: keep sleeves and pant legs rolled down; and ties, strings, and belts away from moving parts
- G. No horse-play
- H. Do not talk to someone while that person is operating a machine
- I. Do not talk to someone while you are operating a machine

V. Identify and Control Common Machine Shop Hazards
- A. Chip formation
- B. Moving machine parts
- C. Spills and other debris
- D. Electrical lines
- E. Hydraulic and pneumatic lines

VI. Cover specific safety policies of the company

TLD-A1-LE
Follow Safety Manuals and All Safety Regulations/Requirements
Attachment 2: MASTER Laboratory Exercise

The purpose of this exercise is to learn to recognize hazards in the workplace. Many of the hazards which you will find there are common practices by people who simply no longer see the danger.

The instructor will guide all students through part of the facility. Each student should write down, in the space provided below, as many safety hazards as are found.

Remember, anyone can cause a hazard merely by failing to see the mop bucket that sits in front of the fire exit every day. Such tunnel vision is the result of familiarity and demonstrates the importance of keeping a fresh perspective *everyday*.

Due to the nature of this laboratory exercise, no answer key is possible.

Safety Hazards

Type	Location	Description

TLD-A1-LA
Follow Safety Manuals and All Safety Regulations/Requirements
Attachment 3: MASTER Laboratory Aid

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and,
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

TLD-A2-HO
Maintain Safe Equipment and Machinery
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Wear protective safety clothing as required;
b. Maintain and use protective guards and equipment on machinery;
c. Locate and properly maintain safe equipment and machinery; and,
d. Use lifting aids when necessary.

Module Outline:

I. Wear Protective Safety Clothing as Required
  A. Different types of safety clothing
    1. Protective from debris, cuts, and blows
      a. Hard hat, safety glasses or goggles, work gloves when necessary
      b. Sturdy footwear
      c. Long sleeved shirt (sleeves rolled down and buttoned)
    2. Fire-retardant and fire-resistant clothing
      a. Long sleeved, 100% cotton shirt
      b. Long pants, 100% cotton
      c. Leather chest protector, sleeves
    3. Optical filters to protect vision from intense light
      a. Welding hood or goggles
      b. Safety glasses or goggles for grinding
      c. Tinted goggles for cutting torch work
    4. Breathing protection
      a. Mask for dust, lint, smoke
  B. Function and use of safety clothing
    1. Man made fiber clothing melts to worker's skin when ignited
    2. Prevents cuts and abrasions
    3. Keep shirt sleeves rolled down (hangs on equipment)
    4. Do not cuff pant legs (causes tripping)
    5. Do not wear jewelry
      a. Catches in moving parts
      b. Conducts electricity
    6. Do not wear neckties around moving parts of machinery
    7. Keep belts and apron strings tied and away from moving equipment

II. Maintain and Use Protective Guards and Equipment on Machinery
  A. Purposes of various guards

    - 1. Do not operate a machine until guards are in place
    - 2. Stop the machine to make adjustments or repairs
    - 3. Disconnect power before removing guards or panels
  - B. Evaluation and maintenance of protective equipment
    - 1. Use only those electrical devices which have been approved by UL (Underwriters' Laboratories)
    - 2. Do not use defective equipment
    - 3. Report defective or unsafe equipment immediately
    - 4. Make sure equipment is properly grounded
- III. Locate and Properly Maintain Safe Equipment and Machinery
  - A. Install safety barriers
  - B. Use caution signs
  - C. Install lock and tag devices
  - D. Know where fire extinguishers are and how to use them
- IV. Use Lifting Aids When Necessary
  - A. Discuss recommended limits on single-person lifting
  - B. Discuss proper lifting methods (use of the legs)
    - 1. Use your legs (bend your knees)
    - 2. Keep the load close to your body
    - 3. Don't twist your body while lifting
    - 4. Make sure you can see where you are going
    - 5. Wear support belts
  - C. Discuss team-lifting
    - 1. Keep load the same height while lifting
    - 2. Move and lift on command
    - 3. Use dolly, wheelbarrow, or forklift
  - D. Determine lifting ratings of lifting equipment
    - 1. Know how your forklift operates
    - 2. Understand load characteristics (weight, size, shape)
  - E. Determine holding ratings of static lifting devices
  - F. Evaluate positions on the workpiece for placement of lifting and holding devices

TLD-A2-LE
Maintain Safe Equipment and Machinery
Attachment 2: MASTER Laboratory Exercise

The instructor will display as much protective equipment, such as welding masks, breathers, and hard hats as is practical and desirable. The instructor should demonstrate the proper use of this equipment.

Due to the nature of this exercise, no answer key is possible.

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and,
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

TLD-A3-HO
Use Safe Operating Procedures for Hand and Machine Tools
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Identify and understand safe machine operating procedures; and,
b. Demonstrate safe machine operation.

Module Outline:

I. Identify and Understand Safe Machine Operating Procedures
  A. Never make adjustments on a machine while it is running
    1. Keep guards in place at all times
    2. Discontinue power before servicing
    3. Keep body parts clear of moving machinery
    4. Beware of sharp edges and flying debris
    5. Secure work pieces to prevent slipping
    6. Never stand directly in line with blades or knives
    7. Avoid kickback
    8. Feed stack into machine correctly
  B. Electrical safety
    1. Use only those electrical devices which have been approved by UL (Underwriters' Laboratories)
    2. Stand on dry surface when working on electrical equipment
    3. Replace defective cords or plugs on equipment
    4. Use only those tools that are in good condition
    5. Use only carbon dioxide or dry chemical fire extinguishers for control of electrical fires
    6. Obtain help when working on equipment that may become energized
  C. Avoid horseplay and practical jokes
  D. Keep work area clean.

II. Demonstrate Safe Machine Operation
  A. Good housekeeping
    1. Materials and equipment should be stacked straight and neat
    2. Keep aisles and walkways clear of tools, materials, and debris
    3. Dispose of scraps and rubbish daily
    4. Clean up spills
    5. Clean and store hand tools
  B. Good techniques
    1. Always walk - do not run
    2. Never talk to or interrupt anyone who is operating a machine

3. Never leave tools or pieces of stock lying on table surface of a machine being used
4. When finished with a machine, turn power OFF and wait until blades or cutters have come to a complete stop before leaving
5. Check stock for defects before machining
    a. Do not use a machine until you understand it thoroughly
    b. Do not jam or rush stock into machinery
    c. Keep guards in place
    d. Make sure power is OFF before working on or servicing
6. Keep hands and fingers away from moving parts
7. Don't try to run too small a piece through the machine
8. Use a brush to clean the surface table
9. Keep your eyes focused on what you are working on
10. Never use an air hose to blow debris off yourself or other workers
11. Report faulty machinery to your supervisor
12. Make sure machinery is properly grounded
13. Never leave a piece of machinery that is running unattended
14. Make sure stack is solidly supported

C. Miscellaneous materials
1. Molten metal - can splash and cause serious burns
2. Chemicals - burn or irritate the skin or cause eye damage
3. Broken glass - causes cuts, can get in the eyes
4. Pointed objects - knives, screwdrivers, punches, staples can puncture the skin
5. Rough material - can scrape your skin and cause infections

D. Machinery
1. Understand the safety regulations that involve the guarding of moving parts
2. Know what parts of the equipment are energized
3. Use all safeguards that have been provided to protect people from machinery
4. See that all guards and protectors are in place before you start to work
5. If you must work nearer, turn the machine off and lock out the power
6. Never work in, around, or near dangerous, unguarded openings without wearing a safety belt and a lifeline that is properly seamed

E. One-fifth of all injuries on the job involve moving parts, machinery, or tools

TLD-A3-LE
Use Safe Operating Procedures for Hand and Machine Tools
Attachment 2: MASTER Laboratory Exercise

For this exercise, the instructor should allow the students to observe other workers at their stations. The students should look for only practices related to safety. Upon returning to class, the students and instructor should discuss what they saw.

NOTE TO ALL STUDENTS: Unless your instructor tells you otherwise, all questions are to be directed to the instructor only. Do **not** disturb you fellow workers at their stations. Such distractions, in and of themselves, pose risks!

Due to the nature of this exercise, no answer key is possible.

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and,
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

TLD-A4-HO
Maintain a Clean and Safe Work Environment
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

- a. Keep work areas clean;
- b. Clean machine/hand tools when work is completed;
- c. Put tools away when work is finished;
- d. Keep isles clear of equipment and materials;
- e. Perform preventive maintenance as required; and,
- f. Understand chemical hazards and the use of Material Safety Data Sheets (MSDS).

Module Outline:

- I. Keep Work Areas Clean
  - A. Discuss the associated dangers of the most common hazards of the work place
    - 1. Tripping/falling hazards caused by spills, loose objects, etc.
      - a. Wipe up spills immediately
      - b. Dispose of scrap material
      - c. Do not wear loose clothing
      - d. Never roll sleeves or pants
      - e. keep shoe strings tied
      - f. Position electrical cords and air hoses in safe areas
    - 2. Chemical hazards
      - a. Inhalants
      - b. Chemical burns
      - c. Flammable liquids
      - d. Explosives and explosive combinations
      - e. Toxins
    - 3. Electrical hazards
    - 4. High-pressure hazards
  - B. Discuss methods of avoiding and correcting common hazards
- II. Clean Machine/Hand Tools When Work Is Completed
- III. Put Tools Away When Work Is Finished
- IV. Keep Isles Clear of Equipment and Materials
- V. Perform Preventive Maintenance as Required
  - A. Discuss that certain machines require extra precautions
  - B. Discuss how general maintenance enhances general safety
- VI. Understand the Use of Material Safety Data Sheets (MSDS)
  - A. What chemicals have MSDS?

B. Where are the MSDS kept?
C. What information is on the MSDS?
  1. Product identification
    a. Specific product name and common name
    b. Precautionary labeling
    c. Safety equipment
    d. Precautionary label statements
    e. Storage color code
  2. Hazardous components
  3. Physical data
    a. Boiling point
    b. Vapor pressure
    c. Melting point
    d. Vapor density
    e. Specific gravity
    f. Evaporation rate
    g. Solubility in water
    h. Percentage of volatile components by volume
    I. Appearance & odor
  4. Fire and explosion hazard data
    a. Flash point
    b. NFPA 704M rating
    c. Flammable limits (upper and lower)
    d. Fire extinguishing media
    e. Special fire-fighting procedures
    f. Toxic gases produced
  5. Health hazard data
    a. Threshold limit value
    b. Permissible exposure limit
    c. Toxicity
    d. Carcinogenicity
    e. Effects of over-exposure
    f. Target organs (those most affected by exposure)
    g. Medical conditions aggravated by exposure
    h. Routes of entry
    I. Emergency and first-aid procedures
  6. Reactivity data
    a. Stability
    b. Hazardous polymerization
    c. Conditions to avoid
    d. Incompatible materials
    e. Decomposition products
  7. Spill and disposal procedures
    a. Procedures: spill or discharge
    b. Procedures: disposal

c. EPA hazardous waste number

8. Protective equipment
    a. Ventilation
    b. Respiratory protection
    c. Eye/skin protection
9. Storage and handling precautions
    a. Storage color code
    b. Special precautions
10. Transportation data and additional information
    a. Domestic transport
        1) DOT shipping name
        2) Hazard class
        3) UN/NA
        4) Labels
        5) Reportable quantity
    b. International
        1) IMO shipping name
        2) Hazard class
        3) UN/NA
        4) Labels

TLD-A4-LE
Maintain a Clean and Safe Work Environment
Attachment 2: MASTER Laboratory Exercise

The instructor will guide all students through part of the facility. Each student should write down as many safety hazards as are found. While this may appear to be an exact duplicate of TLD-A1, the purpose of this exercise is to determine how much more aware of safety and hazards the students have become.

Upon returning to class, the students and the instructor should discuss what the students observed on this tour. Each student should compare his answers to those from TLD-A1, noting any differences and the reasons for those differences.

Due to the nature of this laboratory exercise, no answer key is possible.

Safety Hazards

Type	Location	Description	Recommendations

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and,
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

TLD-A5-HO
Use Safe Material Handling Practices
Attachment 1: MASTER Handout

Standards of Performance:

Student shall demonstrate safety work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Identify the consequences of improper lifting techniques;
b. Recognize when it is unsafe to lift an object alone;
c. Demonstrate proper lifting techniques; and,
d. Identify safety concerns to be addressed when lifting rough, sharp or fragile items.

Module Outline:

I. Discuss the Importance of Lifting Safely
  A. Give each student a copy of the following attachments:
    1. Laboratory aid
    2. Objectives, reading assignments, and module outline
    3. Laboratory worksheet
II. Identify the Steps to Manually Lift Safely
  A. Estimate the load to be lifted. If it is heavier than one person should attempt, get help.
  B. Place feet properly. Spread your feet slightly (comfortably), with one foot slightly ahead of the other and alongside the object.
  C. Bend knees, kneel, or squat. Get close enough to the load to reach under it without bending the back.
  D. Use blocking under objects to get a handhold and to prevent crushed fingers.
  E. Get a good grip. Be sure you can maintain your grip on the object. Use gloves when handling sharp or rough objects.

- F. Let the legs do the lifting. To rise, straighten your legs, letting the powerful leg, arm, and shoulder muscles do the lifting.
- G. Do not turn the body at the waist while carrying a load.
- H. Lower the load to the floor from the carrying position by bending the knees while keeping the back straight. This keeps the load on the leg and arm muscles. Keep fingers and toes clear as the load is set.

III. Discuss Handling Specific Shapes
- A. Locate center of gravity and use this area to lift
- B. Place as much weight as possible as close to lifting mechanism
- C. Place flat weight on button

IV. Discuss Equipment for Material Handling
- A. Hand Trucks
- B. Powered Trucks
- C. Conveyers

V. Discuss and Demonstrate Safe Use of Hand Trucks
- A. Place most of the weight on bed of hand truck
- B. May require two people if one object is difficult to lift on side
- C. Hold object tightly as handle is pulled back
- D. Adjust handle position so more weight is on hand end
- E. After movement, hold object tightly as handle is moved upward
- F. Lift object on one side so bed of truck can be moved away from object

VI. Discuss and Demonstrate Use of Powered Hand Trucks
- A. Watch out for people
- B. Drive unit slowly
- C. Use manual lifting rules

VII. Discuss and Demonstrate Safe Use of Conveyers
- A. Watch for pinch points
- B. Exercise caution when loading and unloading objects
- C. Do not overload conveyers. Rollers may not move freely

VIII. Discuss and Demonstrate Safe Use of Chains and Slings
- A. Storage area should be clean and dry
- B. Watch for pinch points
- C. Inspect for defects before using:
  - 1. Chains
    - a. Wear
    - b. Stretch
    - c. Distortion
    - d. Nicks
    - e. Cracks
    - f. Gauges
  - 2. Slings
    - a. Wear
    - b. Stretch
    - c. Distortion
    - d. Flat, Sling Spots

D. Types
    1. Slings
        a. Choker
        b. Double Choker
        c. Bridle
        d. Basket
        e. Double Basket

IX. Discuss and Demonstrate Safe Use of Chains and Slings

TLD-A5-LE
Use Safe Material Handling Practices
Attachment 2: MASTER Laboratory Exercise

EXERCISE

1. Established standards for safety and conduct shall be followed.
2. Equipment required:
   - Hand truck
   - Conveyor
   - Chains
   - Sling
   - Face shield
   - Side shields
3. Exercises below must be taken in sequence. Instructor must confirm proficiency prior to student's progressing to next exercise.
   - a. Practice manual lifting.
   - b. Practice using hand truck to carry objects.
   - c. Practice using powered truck to carry objects.
   - d. Practice handling specific shapes.
   - e. Practice lifting with slings.
   - f. Practice lifting with chains.
4. Instructor will guide each exercise.
5. Instructor will grade each exercise.

TLD-A5-LA
Use Safe Material Handling Practices
Attachment 3: **MASTER** Laboratory Aid

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and,
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

TLD-A6-HO
Consult and Apply MSDS for Hazards of Various Materials
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Define hazardous material;
b. Identify hazardous material;
c. Know the physical and chemical characteristics;
d. Describe storage, transportation, disposal of hazardous waste; and,
e. Explain material safety data sheets.

Module Outline:

I. Define Hazardous Materials According to the EPA
    A. What makes a material hazardous?
        1. It is hazardous if it causes harm to people or environment
II. Identify Hazardous Materials
    A. Material Safety Data Sheets (MSDS)
        1. Companies that make and distribute hazardous substances must provide your company with a MSDS on hazardous material
        2. MSDS developed by OSHA
        3. MSDS is part of the Hazard Communication Standard or Right to Know regulation
        4. MSDS is an easy reference for information on hazardous substances
    B. Information in MSDS
        1. What it is
        2. Who makes or sells it
        3. Where they are located
        4. Why it is hazardous
        5. How you can be exposed to the hazard
        6. Conditions that could increase the hazard
        7. How to handle the substance safely
        8. Protection to use while working with it
        9. What to do if exposed
        10. What to do if there is a spill or emergency
III. Know the Chemical and Physical Characteristics
    A. Corrosive
        1. Burns skin or eyes on contact
    B. Explosive
    C. Flammable

        1. Catches fire easily
    D. Radioactive
    E. Reactive
        1. Burns, explodes
        2. Releases toxic vapors
    F. Toxic
        1. Causes illness or possibly death

IV. Describe Storage, Transportation, Disposal
    A. Resource Conservation and Recovery Act (RCRA)
        1. Designed to reduce hazards of waste by tracking and regulating the substance
        2. Method used is called from cradle (creation) to grave (disposal)
        3. Tells what hazards are and how to keep track of them
        4. Sets up rules for handling wastes
        5. Provides strict documentation system to track them
    B. Your employer may have to report to the Environmental Protection Agency (EPA) on how the company is meeting the RCRA responsibilities
    C. The law requires companies that treat, store, or dispose of hazardous wastes to:
        1. Must have a permit
        2. Identify and analyze new hazardous waste
        3. Provide a secure facility that keeps unauthorized people out
        4. Inspect the facility regularly
        5. Have a contingency plan for fire, explosion, and spills
        6. Practice emergency response for fire, explosion, spills
        7. Provide proper protective clothing and equipment
        8. Maintain EPA-required records

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and,
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

TOOL AND DIE MAKER .... skilled workers who produce tools, dies, and special guiding and holding devices that are used in machining.

Duties		Tasks												
A	Practice Safety	A-1 Follow safety manuals and all safety regulations/ requirements	A-2 Maintain safe equipment and machinery	A-3 Use safe operating procedures for hand and machine tools	A-4 Maintain a clean and safe work environment	A-5 Use safe material handling practices	A-6 Consult and apply MSDS for hazards of various materials							
B	Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Perform basic algebraic operations	B-3 Use basic geometric principles	B-4 Perform basic trigonometric functions	B-5 Use and apply Cartesian Coordinate System								
C	Interpret Engineering Drawings and Related Documents	C-1 Interpret and understand basic layout/types of drawings	C-2 Interpret, review, and apply blueprint notes, dimensions, and tolerances	C-3 Use and apply Geometric Dimensioning and Tolerancing (GD&T)	C-4 Demonstrate traditional mechanical drafting and sketching techniques	C-5 Understand and use quality systems								
D	Demonstrate Knowledge of Manufacturing Materials	D-1 Identify materials with desired properties	D-2 Identify materials and processes to produce a part	D-3 Discuss classification systems for metal										
E	Measure/ Inspect	E-1 Understand metrology terms	E-2 Select measurement tools	E-3 Measure with hand held instruments	E-4 Eliminate measurement variables	E-5 Measure/inspect using surface plate and accessories	E-6 Inspect using stationary equipment							
F	Demonstrate Knowledge of Manufacturing Processes	F-1 Discuss metal cutting and metal cutting tools	F-2 Operate metal saws	F-3 Operate drill presses and tooling	F-4 Operate engine and turret lathes and tooling	F-5 Operate vertical and horizontal mills and tooling	F-6 Operate precision grinders	F-7 Operate heat treating equipment and processes	F-8 Operate sheet metal equipment	F-9 Operate welding equipment and processes	F-10 Estimate time required/ cost to produce a part			
G	Use Computers	G-1 Use computer operating systems	G-2 Understand computer terminology	G-3 Use file management systems	G-4 Install and use software packages									
H	Perform CAD/ CAM and CNC Programming Tasks	H-1 Discuss fundamentals of CNC machines and controls	H-2 Program and operate CNC milling machine and machining center	H-3 Program and operate CNC lathe	H-4 Use Computer-Aided Drafting (CAD) system	H-5 Create 3-D solid models	H-6 Use Computer-Aided Manufacturing (CAM) system							
I	Perform Tool and Die Making Operations	I-1 Discuss basic types and functions of jigs and fixtures	I-2 Utilize concepts of jig and fixture design	I-3 Demonstrate understanding of different types of industrial dies	I-4 Utilize basic die theory	I-5 Utilize principles of die design	I-6 Perform tool and die repair	I-7 Demonstrate tool and die making skills						
J	Operate Electrical Discharge Machine (EDM)	J-1 Discuss fundamentals of EDM	J-2 Setup and operate conventional sinker EDM	J-3 Program, setup, and operate CNC sinker EDM and EDM drill	J-4 Program, setup, and operate CNC wire EDM									

TLD [illegible]
[illegible]

Duty B

TLD-B1-HO
Perform Basic Arithmetic Functions
Attachment 1: **MASTER** Handout

Objective(s):

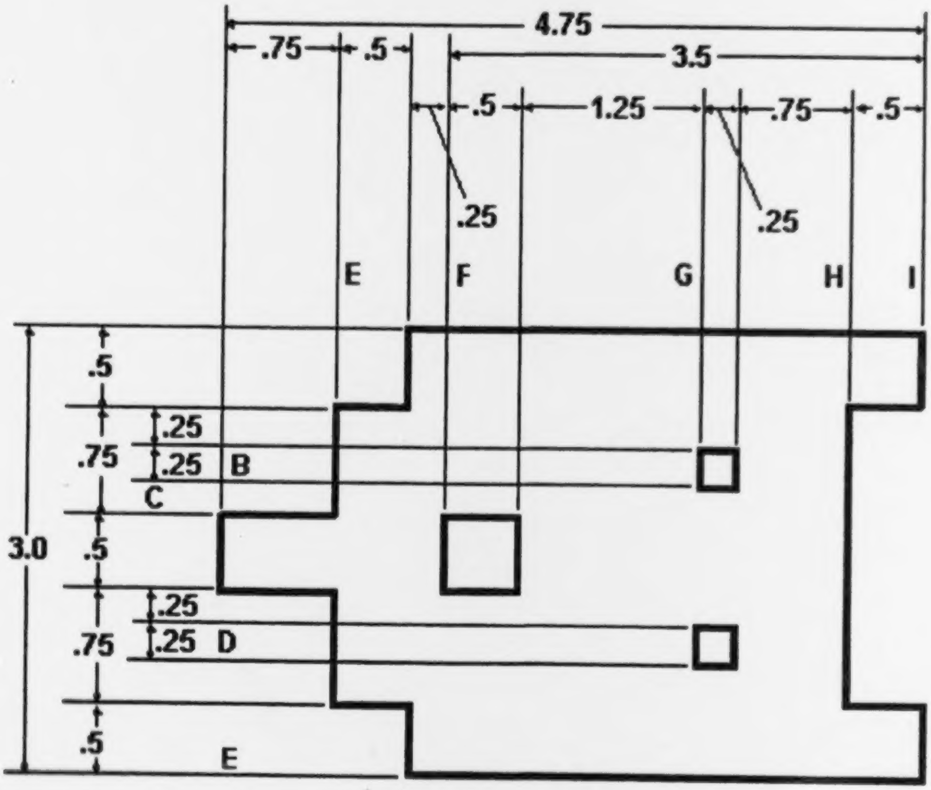
Upon completion of this unit the student will be able to:

a. Add, subtract, multiply, and divide whole numbers;
b. Add, subtract, multiply, and divide fractions; and,
c. Add, subtract, multiply, and divide decimals.

Module Outline:

I. Add, Subtract, Multiply, and Divide Whole Numbers
  A. Addition of whole numbers
  B. Subtraction of whole numbers
  C. Multiplication of whole numbers
  D. Division of whole numbers
  E. Hierarchy of operations
II. Add, Subtract, Multiply, and Divide Fractions
  A. Common operations
    1. Least common denominator
    2. Factoring for reduction
    3. Improper fractions
    4. Mixed numbers
  B. Addition
  C. Subtraction
  D. Multiplication
  E. Division
III. Add, Subtract, Multiply, and Divide Decimals
  A. Aligning the decimal (addition and subtraction)
  B. Moving the decimal
    1. In division, move the decimal to the right until it is eliminated in the divisor. Move the decimal the same number of places to the right in the dividend.
    2. In multiplication, count the total number of decimals places in the two numbers being multiplied. Beginning in the product at the *right-most digit,* count off the same number of places and place the decimal.

TLD-B1-LA
Perform Basic Arithmetic Functions
Attachment 2: MASTER Laboratory Aid


4.75
.75
.5
3.5
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1.25
.75
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.25
E
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I
.5
.25
.75
.25
B
C
3.0
.5
.25
.75
.25
D
.5
E

TLD-B2-HO
Perform Basic Algebraic Operations
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Understand basic algebraic symbols and expressions; and,
b. Use equations to solve problems.

Module Outline:

I. Understand Basic Algebraic Symbols and Expressions
  A. Symbols
    1. Addition "+"
    2. Subtraction "-"
    3. Multiplication "·"; "x", and parentheses
    4. Division "÷" and "/"
    5. Exponents are generally limited to the term "square" in linear measurements. This is the "^{2}" notation.
  B. Expressions
    1. Sum: the total amount resulting from addition
    2. Difference: the remaining amount resulting from subtraction
    3. Product: the total amount resulting from multiplication
    4. Exponent: a superscript which indicates the number of times a quantity is multiplied by itself
    5. Quotient: the amount resulting from division

II. Use a Few Easy-to-Remember Rules to Solve Equations
  A. *P*lease *E*xcuse *M*y *D*ear *A*unt *S*ue indicates the order in which equations are solved. Each letter shows one of the algebraic notations or functions: Parentheses, Exponents, Multiply, Divide, Add, Subtract.
    1. In the expression $(x - y)^2 + 2x^2 - y^2$, the *p*arentheses, which must be worked first, indicate that y must be subtracted from x. Since we don't know what x and y are, we can't do that, and must move on.
    2. The next step is to square the term $(x - y)$, as indicated by the *e*xponent. This gives us $x^2 - 2xy + y^2 + 2x^2 - y^2$.
    3. There is no operable *m*ultiplication or *d*ivision in this expression, so we move on.
    4. Grouping all the like terms to make seeing the answer easier, we have $x^2 + 2x^2 + y^2 - y^2 - 2xy$.
    5. *A*dding, we now have $3x^2 + y^2 - y^2 - 2xy$.
    6. *S*ubtracting, which is the final step, renders $3x^2 - 2xy$.

B. *FOIL* gives the order in which you multiply the terms in expressions. Let us go back to squaring (multiplying by itself) (x - y) from the expression above.

1. *F*irst terms first, so, in (x - y)(x - y), multiply the two x's first. This give us x^2.
2. *O*utside terms come next, so multiply the first x by the second y. This gives us $x^2 - xy$.
3. *I*nside terms come next, so multiply the first y by the second x. This gives us $x^2 - xy - xy$.
4. *L*ast terms are last, so multiply the two y's. This gives us a complete (if complex) $x^2 - xy - xy + y^2$.
5. Simplifying gives us the expression $x^2 - 2xy + y^2$.

C. Thinking about algebra can be daunting to almost anybody, but once you see that algebra is just juggling done with numbers and with a lot of two-dollar words stuck all over it, algebra becomes rather simple. Remember, algebra is just taking the four basic mathematic operations (addition, subtraction, multiplication, and division) and using them to find out something that you didn't know to start with.

D. Word problems are what you will encounter every day in the shop. Someone will tell you to get so much material and make so many parts from it. As you progress in skill, they will tell you to get such-and-such material and make so many parts from it. Your mastery of basic algebra will make these problems easy to solve.

TLD-B3-HO
Use Basic Geometric Principles
Attachment 1: **MASTER** Handout

Objective(s):

Upon completion of this module the student will be able to:

- a. Calculate angles;
- b. Calculate length of triangle sides;
- c. Calculate radius, diameter, circumference, and area of a circle; and,
- d. Understand the applications of planar geometry to solid forms.

Module Outline:

- I. Some Rules of Angles
  - A. Angles are usually expressed in degrees, minutes, and seconds
  - B. No angle has more than 360°
  - C. Angles have three points which determine them
  - D. An angle having 90° is a right angle
- II. Triangles
  - A. Pythagorean Theorem: $a^2 + b^2 = c^2$
  - B. All the angles in a triangle will add up to 180°, every day, every time, every triangle
  - C. Have three corners. If one of them is 90°, then it is a right triangle.
  - D. The absolute size of a triangle cannot be determined by its angles alone. At least one side must be known.
- III. Circle
  - A. 360°, every day, every time, every circle
  - B. Pi (π) 3.1416 and its importance
  - C. $2\pi r = d$, where r is the circle's radius and d, its diameter
- IV. Rectangles and Parallelograms
  - A. Squares and rectangles
    - 1. Have four 90° corners
    - 2. Squares are rectangles all of whose sides are equal
  - B. Parallelograms
    - 1. Have four corners not 90°
    - 2. Have (at least) two parallel sides
- V. Relating Planar Geometry to Solid Forms

  In reality, planar geometry is an abstract way of looking at *parts* of solid things. Look at a piece of 1" CRS—at each end, it is a circle, so all the rules of circles apply to it, but only when looked at from the end. When you look at it from the sides, the rules for lines apply. So, that piece of 1" CRS, which is actually a cylinder, can be looked at as two circles joined by a line. Square workpieces have the same properties. No matter which way you look at them, each face is a

rectangle or a parallelogram; and each face is subject to the rules of rectangles and parallelograms. Tapers are unequal circles joined by an incomplete triangle.

TLD-B4-HO
Perform Basic Trigonometric Operations
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

- a. Solve for unknown angles;
- b. Solve for unknown sides; and,
- c. Calculate bolt hole patterns.

Module Outline:

- I. Solve for Unknown Angles
  - A. Right triangles
    - 1. Sine Law: $\sin a$ = side opposite divided by hypotenuse
    - 2. Cosine Law: $\cos a$ = side adjacent divided by hypotenuse
    - 3. Tangent Law: $\tan a$ = side opposite divided by side adjacent
    - 4. *O*scar *H*as *A* *H*eap *O*f *A*pples is a quick device to remember the above three runes.
      - a. Sine ∠ = *O*pposite/*H*ypoteneuse
      - b. Cosine ∠ = *A*djacent/*H*ypoteuse
      - c. Tangent ∠ = *O*pposite/*A*djacent
  - B. Oblique Triangles
    - 1. Lengths of three sides (A, B, C) all known
      - a. $\cos a = (B^2 + C^2 - A^2)/2BC$
      - b. $\sin b = (B \times \sin a)/A$
      - c. $c = 180° - (a + b)$
    - 2. Two angles (a and b) known
      $c = 180° - (a + b)$
    - 3. Two sides and interior angle (A, c, B) known
      - a. $\tan a = (A \times \sin c)/B-(A \times \cos c)$
      - b. $b = 180° - (a + c)$
      - c. $C = (A \times \sin c)/\sin a$
    - 4. Two sides and an opposite angle (a, A, B) known
      - a. $\sin b = (B \times \sin a)/A$
      - b. $c = 180° - (a + b)$
      - c. $C = (A \times \sin c)/\sin a$
- II. Solve for Unknown Sides
  - A. Right triangles, any two sides known, where C is the hypotenuse
    $A^2 + B^2 = C^2$
  - B. One side and two angles (a, b, A) known
    - 1. $c = 180° - (a + b)$
    - 2. $B = (A \times \sin b)/\sin a$

3. $C = (A \times \sin c)/\sin a$

C. Two sides and the interior angle (A, B, *c*) known

$C = \sqrt{[A^2 + B^2 - (2AB \times \cos c)]}$

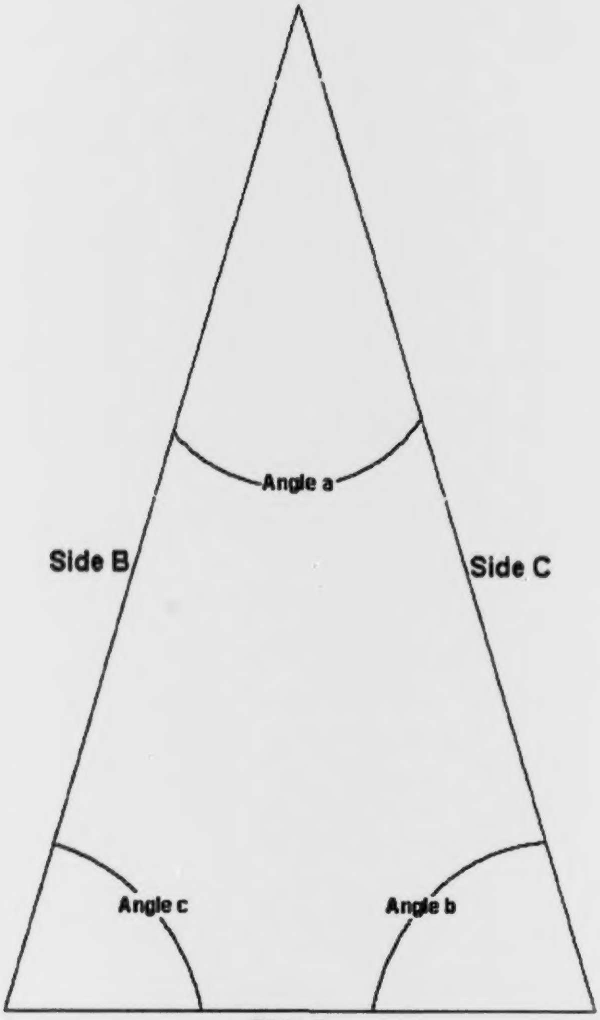
D. Three angles known

It is impossible to determine the actual length of any side when only the sizes of the three angles are known. The length of at least one side *must* be known in order to calculate the lengths of the other sides.

III. Calculate Bolt Hole Patterns

A. Discuss the construction of reference triangles to solve bolt-hole patterns

B. Discuss circles and their uses in figuring bolt-hole patterns.


Angle a
Side B
Side C
Angle c
Angle b
Side A

Basic Triangle - TLD-B4

TLD-B5-HO
Use and Apply Cartesian Coordinate System
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:
- a. Identify points using the Cartesian coordinate system;
- b. Identify points using the absolute dimensioning system;
- c. Identify points using the incremental dimensioning system; and,
- d. Identify points using the polar coordinate system.

Module Outline:

I. Identify Points Using the Cartesian Coordinate System
   - A. Describe the Cartesian (rectangular) coordinate system - the basis for all machine movement
     1. Define *axis* - any direction of movement on a machine tool. The spindle is always defined as the Z axis on 3 axis systems.
     2. Discuss the plus and minus aspects of an axis
     3. Discuss the quadrants I, II, III, and IV. Note that the signs for the X- and Y-axes change for the different quadrants.
     4. Discuss the concept of three dimensional locations
     5. Discuss how points are described in both 2- and 3-axis systems
     6. Describe how a part fits into the axis system

II. Identify Points Using the Polar Coordinate System
   - A. Describe the *polar coordinate system* - a system by which all points are located around a known location (or pole).
     1. Points are usually identified by a known distance from the pole and a given angle from the horizontal (3:00 o'clock position equals zero degrees)
     2. Positive angles are measured from angle zero in a counterclockwise direction
     3. Negative angles are measured from angle zero in a clockwise direction
   - B. Student practice

III. Locate Points Using the Absolute Dimensioning System
   - A. Define *absolute positioning*- in absolute positioning, all machine locations are taken from one fixed zero (origin) point. This origin point does not change.
   - B. This corresponds to the datum dimensioning method used by drafters. In datum dimensioning, all dimensions on a drawing are placed in reference to one fixed zero point.
   - C. Student practice

IV. Locate Points Using the Incremental Dimensioning System
   A. Define *incremental positioning*- in incremental positioning, the X0/Y0 moves with each position change. The current position, in fact, becomes the X0/Y0 for the next positioning move.
   B. This corresponds to the delta dimensioning method used by drafters. In delta dimensioning, all dimensions on a drawing are "chain-linked." Each location is dimensioned from the previous one.
   C. Student practice

TOOL AND DIE MAKER .... **skilled workers who produce tools, dies, and special guiding and holding devices that are used in machining.**

	Duties	Tasks												
A	Practice Safety	A-1 Follow safety manuals and all safety regulations/ requirements	A-2 Maintain safe equipment and machinery	A-3 Use safe operating procedures for hand and machine tools	A-4 Maintain a clean and safe work environment	A-5 Use safe material handling practices	A-6 Consult and apply MSDS for hazards of various materials							
B	Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Perform basic algebraic operations	B-3 Use basic geometric principles	B-4 Perform basic trigonometric functions	B-5 Use and apply Cartesian Coordinate System								
C	Interpret Engineering Drawings and Related Documents	C-1 Interpret and understand basic layout/types of drawings	C-2 Interpret, review, and apply blueprint notes, dimensions, and tolerances	C-3 Use and apply Geometric Dimensioning and Tolerancing (GD&T)	C-4 Demonstrate traditional mechanical drafting and sketching techniques	C-5 Understand and use quality systems								
D	Demonstrate Knowledge of Manufacturing Materials	D-1 Identify materials with desired properties	D-2 Identify materials and processes to produce a part	D-3 Discuss classification systems for metal										
E	Measure/ Inspect	E-1 Understand metrology terms	E-2 Select measurement tools	E-3 Measure with hand held instruments	E-4 Eliminate measurement variables	E-5 Measure/inspect using surface plate and accessories	E-6 Inspect using stationary equipment							
F	Demonstrate Knowledge of Manufacturing Processes	F-1 Discuss metal cutting and metal cutting tools	F-2 Operate metal saws	F-3 Operate drill presses and tooling	F-4 Operate engine and turret lathes and tooling	F-5 Operate vertical and horizontal mills and tooling	F-6 Operate precision grinders	F-7 Operate heat treating equipment and processes	F-8 Operate sheet metal equipment	F-9 Operate welding equipment and processes	F-10 Estimate time required/ cost to produce a part			
G	Use Computers	G-1 Use computer operating systems	G-2 Understand computer terminology	G-3 Use file management systems	G-4 Install and use software packages									
H	Perform CAD/ CAM and CNC Programming Tasks	H-1 Discuss fundamentals of CNC machines and controls	H-2 Program and operate CNC milling machine and machining center	H-3 Program and operate CNC lathe	H-4 Use Computer-Aided Drafting (CAD) system	H-5 Create 3-D solid models	H-6 Use Computer-Aided Manufacturing (CAM) system							
I	Perform Tool and Die Making Operations	I-1 Discuss basic types and functions of jigs and fixtures	I-2 Utilize concepts of jig and fixture design	I-3 Demonstrate understanding of different types of industrial dies	I-4 Utilize basic die theory	I-5 Utilize principles of die design	I-6 Perform tool and die repair	I-7 Demonstrate tool and die making skills						
J	Operate Electrical Discharge Machine (EDM)	J-1 Discuss fundamentals of EDM	J-2 Setup and operate conventional sinker EDM	J-3 Program, setup, and operate CNC sinker EDM and EDM drill	J-4 Program, setup, and operate CNC wire EDM									

TLD-C1-HO
Interpret and Understand Basic Layout/Types of Drawings
Attachment 1: **MASTER** Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Identify types of drawings;
b. Identify parts of a drawing and list components of each;
c. Identify types of lines on a drawing;
d. List and describe the different views found on a drawing;
e. List and apply the three primary planes of projection;
f. List and apply the six principle views;
g. Apply auxiliary views; and,
h. Apply sectional views.

Module Outline:

I. Interpret and Understand Basic Layout of Drawings
    A. ANSI & ISO sheet size layout
    B. ANSI & ISO forms of lettering arrangements
II. Interpret and Understand Types of Drawings
    A. Orthographic and multi-view projection
    B. Perspective or central projection
    C. Oblique projection
    D. Axonometric projection
III. Identify Parts of a Blue Print/Drawing and List Components of Each
    A. Body
    B. Title block
        1. Drawing number
        2. Drawing title
        3. Scale
        4. Signatures
        5. Job number
        6. Material list number
        7. Reference drawings
        8. Distribution section
        9. Revision
        10. Work order number
    C. Bill of Materials
        1. Piece mark number
        2. Number of pieces required for each piece mark
        3. Description of materials
        4. Traceability requirements

        5. Material specifications
        6. Length
        7. Gross weight
        8. Total weight

IV. Identify Types of Lines on a Drawing
    A. Visible line
    B. Hidden line
    C. Center line
    D. Section line
    E. Dimension line
    F. Extension line
    G. Leaders line
    H. Cutting plane/viewing plane line
    I. Short-break line
    J. Long-break line
    K. Phantom line
    L. Stitch line
    M. Chain line
    N. Cylindrical break/conventional break lines

V. List and Describe the Different Views Found on a Drawing
    A. One view
        1. Sphere
        2. Plate
    B. Two view
        1. Cylinder
        2. Rectangle
    C. Three view
        1. Pyramids
        2. Multi-view projection

VI. List and Apply the Three Primary Planes of Projection
    A. Frontal projection plane
    B. Profile projection plane
        1. Right side
        2. Left side
    C. Horizontal projection plane

VII. List and Apply the Six Principal Views
    A. Front view
    B. Rear view
    C. Right side view
    D. Left side view
    E. Top view
    F. Bottom view

VIII. List and Apply Auxiliary Views
    A. Surfaces needing auxiliary views
        1. Inclined surfaces

    2. Oblique surfaces
  B. Primary auxiliary views
  C. Secondary auxiliary views
  D. To generate an auxiliary view
    1. Folding-line method
    2. Reference-plane method
  E. Classifications of auxiliary views
    1. Depth auxiliary views
    2. Height auxiliary views
    3. Width auxiliary views
  F. Dihedral angles
  G. Partial auxiliary views
  H. Half auxiliary views
  I. Auxiliary sections
  J. Basic four uses of auxiliary views
    1. True length of line
    2. Point view of line
    3. Edge view of plane
    4. True size of plane
IX. List and Apply Sectional Views
  A. Need for sectional views
  B. Cutting plane
    1. Direction
    2. Labels
    3. Alternate styles
  C. Section lining
    1. Techniques
    2. Symbols
  D. Types of sectional views
    1. Full section
    2. Half/partial section
    3. Broken-out section
    4. Revolved section
    5. Removed section
    6. Offset section
    7. Aligned section
    8. Auxiliary section
    9. Partial section

TLD-C2-HO
Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Distinguish between general and specific notes;
b. Interpret and apply general and specific notes;
c. Determine and apply dimensions on a drawing;
d. Identify basic symbols and abbreviations found on a drawing;
e. Identify tolerances or limits on a drawing; and,
f. Identify ANSI limits and fits.

Module Outline:

I. Distinguish Between General and Specific Notes
  A. General notes
  B. Specific notes/local notes
II. Interpret and Apply General and Specific Notes
  A. General notes applied
    1. Title strip/title block
    2. Parts list/bill of material
  B. Interpret general notes
    1. Including material
    2. General tolerances
    3. Heat treatment
    4. Pattern information
    5. Processes of manufacture
    6. Requirements of the product
  C. Interpret specific notes
    1. Apply to specific operations
    2. Apply to specific processes of manufacture
    3. Apply to the requirements of the product
III. Determine and Apply Dimensions on a Drawing
  A. Identify organizations that determine dimension standards
    1. American National Standards Institutes (ANSI)
    2. International Standards Organization (ISO)
  B. Determine dimensions on a drawing
    1. Size dimensions
    2. Location dimensions
  C. Applying dimensions on a drawing
    1. Scale of drawing
    2. Techniques of dimensioning

        3. Placement of dimensions
        4. Choice of dimensions
        5. Types of lines used in the dimensioning process
        6. Arrowheads used on drawings
        7. Leaders used on drawings
        8. Dimensioning systems
            a. Fractional
            b. Decimal
            c. Metric
            d. Combination dimensioning
        9. Dimension figures
        10. Direction of dimension figures
            a. Unidirectional system
            b. Aligned system
        11. Dimensioning angles
        12. Dimensioning arcs
        13. Dimensioning fillets and rounds
        14. Identify surfaces to be machined
        15. Contour dimensioning
        16. Dimensioning of curves
        17. Dimensioning of rounded-end shapes
        18. Dimensioning of threads
        19. Dimensioning of tapers
        20. Dimensioning of chamfers
        21. Dimensioning shaft centers
        22. Dimensioning keyways
        23. Dimensioning knurls
            a. Diamond
            b. Straight
        24. Dimensioning along curved surfaces
        25. Tabular dimensions
        26. Dimensioning standards
        27. Coordinate dimensioning

IV. Identify Basic Symbols and Abbreviations Found on a Drawing
    A. Traditional terms used to describe various shapes, processes, and size
    B. Identify abbreviations used to describe various shapes, processes, and size
    C. Identify a variety of dimensioning symbols used to replace traditional terms and abbreviations

V. Identify Tolerances or Limits on a Drawing
    A. Identify tolerances or limits
        1. Nominal size
        2. Basic size or dimension
        3. Actual size
        4. Tolerance

5. Limits
6. Allowance

B. Methods of expressing tolerances
1. General tolerances
2. Limit dimensioning
3. Plus and minus dimensioning
   a. Unilateral system
   b. Bilateral system
4. Single-limit dimensioning
5. Angular tolerances

VI. Identify ANSI Limits and Fits

A. Fits between mating parts
1. Clearance fit
2. Interference fit
3. Transition fit
4. Line fit

B. Limits and fits for cylindrical parts
1. Running or sliding clearance fits
2. Locational clearance fits
3. Transition clearance interference fits
4. Locational interference fits
5. Force or shrink fits

TLD-C3-HO
Use and Apply Geometric Dimensioning and Tolerancing (GD&T)
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

- a. Distinguish between conventional and geometric dimensioning and tolerancing;
- b. Explain and use geometric positional tolerancing and symbols;
- c. Explain and use tolerances of form and symbols;
- d. Explain and use the feature control symbol; and,
- e. Explain and use modifiers in geometric dimensioning and tolerancing.

Module Outline:

- I. Distinguish Between Conventional and Geometric Dimensioning and Tolerancing
  - A. General/conventional tolerancing
    - 1. Definitions of general/conventional tolerancing
      - a. Dimension
      - b. Reference dimension
      - c. Feature
      - d. Feature of size
      - e. Actual size
      - f. Stock size
    - 2. Maximum material condition
    - 3. Least material condition
    - 4. Basic fits
    - 5. Clearance fit
    - 6. Allowance
    - 7. Clearance
    - 8. Force fit
  - B. Geometric dimensioning and tolerancing
    - 1. Definition of geometric dimensioning and tolerancing
    - 2. Dimensioning rules
    - 3. Dimensioning units
- II. Explain and Use Geometric Positional Tolerancing and Symbols
  - A. Explain positional / location tolerances
  - B. Identify and use geometric position tolerancing symbols
    - 1. Position
    - 2. Concentricity
    - 3. Symmetry
- III. Explain and Use Tolerances of Form Symbols
  - A. Explain form tolerances

- B. Identify and use tolerances of form symbols
  - 1. Straightness
  - 2. Flatness
  - 3. Circularity
  - 4. Cylindrical
- IV. Explain and Use Profile Tolerances
  - A. Explain profile tolerance
  - B. Identify and use profile tolerance symbols
    - 1. Profile of a line
    - 2. Profile of a surface
    - 3. Profile of an arc
    - 4. Profile of irregular curves
    - 5. Profile of coplanar surfaces
- V. Explain and Use Tolerances of Orientation
  - A. Explain orientation tolerances
  - B. Identify and use orientation tolerance symbols
    - 1. Parallelism
    - 2. Perpendicularity
    - 3. Angularity
- VI. Explain and Use Runout Tolerances
  - A. Explain runouts
    - 1. Circular
    - 2. Total
  - B. Identify and use runout tolerances symbols
    - 1. Circular
    - 2. Total
- VII. Explain and Use Modifiers in Geometric Dimensioning and Tolerancing
  - A. Maximum material condition (MMC)
  - B. Regardless of feature size (RFS)
  - C. Least material condition (LMC)
  - D. Datum feature symbol
  - E. Datum reference frame concept
    - 1. Primary datum plane
    - 2. Secondary datum plane
    - 3. Tertiary datum plane
  - F. Datum target symbol
    - 1. Target point
    - 2. Target line
    - 3. Target area
- VIII. Explain and Use the Feature Control Frame
  - A. Explain feature control frame
  - B. Explain the compartments of a feature control frame
    - 1. Geometric characteristic symbol
    - 2. Geometric tolerance
    - 3. Zone descriptor

        4. Material condition symbol
        5. Primary datum reference
        6. Secondary datum reference
        7. Tertiary datum reference

IX. Additional Supplementary Modifying Symbols
    A. Explain and use additional modifying symbols.
        1. Diameter
        2. Radius R
        3. Reference ( )
        4. Counterbore/spotface L/
        5. Square □
        6. Dimension origin O
        7. Slope
        8. Projected tolerance zone
        9. Spherical diameter
        10. Spherical radius
        11. Arc length
        12. Counter sink
        13. Depth
        14. Conical taper
        15. Place, times, or by
        16. Basic dimension

TLD-C4-HO
Demonstrate Traditional Mechanical Drafting and Sketching Techniques
Attachment 1: **MASTER** Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Demonstrate use of drafting machine;
b. Demonstrate use of drafting instruments;
c. Demonstrate drafting techniques used to create basic geometric elements;
d. Demonstrate sketching techniques;
e. Demonstrate isometric sketching;
f. Demonstrate oblique sketching; and,
g. Demonstrate perspective sketching.

Module Outline:

I. Demonstrate Use of Drafting Machine
    A. Types of drafting machines
        1. Elbow drafting machines
            a. Controlling head
            b. Vernier
        2. Track drafting machines
            a. Controlling head
            b. Vernier
II. Demonstrate Use of Drafting Instruments
    A. Drawing pencil types
        1. Drawing pencil
            a. Grade
            b. Sharpening
        2. Mechanical pencil
            a. Grade
            b. Sharpening
        3. Thin-lead mechanical pencil
            a. Grade
            b. Lead diameter
    B. Types of erasers
        1. Pink pearl
        2. Mars - plastiz
        3. Artgum
        4. Electric erasing machine
    C. Erasing shield
    D. Dusting brush

- E. Types of triangles
    - 1. 45° triangle
    - 2. 30° x 60° triangle
    - 3. Adjustable triangle
- F. Protractor
- G. Types of scales
    - 1. Metric scale
    - 2. Engineers' scale
    - 3. Mechanical engineers' scale
    - 4. Decimal scale
    - 5. Architects' scale
    - 6. Combination scale
- H. Drawing instruments
    - 1. Compass
        - a. Giant bow compass
        - b. Beam attachment
    - 2. Beam compass/trammel
    - 3. Dividers
- I. Irregular/french curve
- J. Templets
    - 1. Circle
    - 2. Ellipse
    - 3. Chemical
    - 4. Electrical
    - 5. Architectural
    - 6. Mechanical
- K. Lettering guide
- L. Calculator
- M. Drafting tape
- N. Pencil lead sharpening devices
    - 1. Lead pointer
    - 2. Sandpaper pad
- O. Drafting board table
- P. Drafting paper/detail paper
- Q. Tracing papers kinds
    - 1. Treated with oils, waxes, and similar substances (vellums)
    - 2. Non-treated papers
- R. Tracing cloth
- S. Polyester film

III. Demonstrate Drafting Techniques to Create Basic Geometric Elements

- A. Perform drafting techniques necessary to bisect a line or a circular arc
- B. Perform drafting techniques necessary to bisect an angle and to transfer an angle
- C. Perform drafting techniques necessary to construct a line parallel to a given line at a given distance

- D. Perform drafting techniques necessary to divide a line into equal or proportional parts
- E. Perform drafting techniques necessary to construct a triangle with the length of the sides given
- F. Perform drafting techniques necessary to inscribe a circle in a triangle
- G. Perform drafting techniques necessary to construct a right triangle with hypotenuse and one side given
- H. Perform drafting techniques necessary to construct a line through a point and perpendicular to a given line at the prescribed point and from a point off the given line
- I. Perform drafting techniques necessary to construct a square with a side given
- J. Perform drafting techniques necessary to inscribe a regular pentagon in a given circle
- K. Perform drafting techniques necessary to inscribe and circumscribe a hexagon on a given circle
- L. Perform drafting techniques necessary to inscribe an octagon in a given square
- M. Perform drafting techniques necessary to construct a circle through three given points not in a straight line
- N. Perform drafting techniques necessary to construct a circle of a given size tangent to a given line and passing through a given point
- O. Perform drafting techniques necessary to construct a circle tangent to a given line at a prescribed point on that line and passing through a given point not on that line
- P. Perform drafting techniques necessary to construct a circle of a given size tangent to a given circle and passing through a given point
- Q. Perform drafting techniques necessary to construct an arc of a given size tangent to two given intersecting lines at acute or obtuse angles
- R. Perform drafting techniques necessary to construct a given size circle tangent to two given circles
- S. Perform drafting techniques necessary to construct an ellipse using the concentric circle method with major and minor diameters given
- T. Perform drafting techniques necessary to construct an approximate ellipse with major and minor diameters given

IV. Demonstrate Sketching Techniques
- A. Horizontal lines
- B. Vertical lines
- C. Inclined lines
- D. Circles
- E. Arcs
- F. Ellipses

V. Demonstrate Isometric Sketching
- A. Box construction technique
- B. Blocking recesses and projections

  C. Dim all construction lines
  D. Heavy in all final lines
VI. Demonstrate Oblique Sketching
  A. Block in front view
  B. Sketch receding lines
  C. Dim all construction lines
  D. Heavy in all final lines
VII. Demonstrate Perspective Sketching
  A. One-point perspective
    1. Sketch the true front view and select vanishing point
    2. Sketch receding lines to vanishing point
    3. Estimate the depth
    4. Dim all construction lines
    5. Heavy in all final lines
  B. Two-point perspective
    1. Sketch the front corner of view in true height and locate two vanishing points on a horizontal line
    2. Estimate depth and width and sketch enclosing box
    3. Block in all details
    4. Dim all construction lines
    5. Heavy in all final lines
    6. Make contour lines thicker and inside lines thinner

TLD-C4-LE
Demonstrate Traditional Mechanical Drafting and Sketching Techniques
Attachment 2: MASTER Laboratory Exercise

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1. The instructor will:
    - a. Demonstrate use of drafting machine;
    - b. Demonstrate use of drafting instruments;
    - c. Demonstrate drafting techniques to create basic geometric elements;
    - d. Demonstrate sketching techniques, including:
        - (1) Isometric sketching;
        - (2) Oblique sketching; and,
        - (3) One-point and two-point perspective sketching.

2. The student will:
    - a. Demonstrate use of drafting machine;
    - b. Demonstrate use of drafting instruments;
    - c. Demonstrate drafting techniques to create basic geometric elements, which include:
        - (1) Bisecting a line or a circular arc;
        - (2) Bisecting an angle and to transfer an angle;
        - (3) Constructing a line parallel to a given line at a given distance;
        - (4) Dividing a line into equal or proportional parts;
        - (5) Constructing a triangle with the length of the sides given;
        - (6) Inscribing a circle in a triangle;
        - (7) Constructing a right triangle with hypotenuse and one side given;
        - (8) Constructing a line through a point and perpendicular to a given line at the prescribed point and from a point off the given line;
        - (9) Constructing a square with a side given;
        - (10) Inscribing a regular pentagon in a given circle;
        - (11) Inscribing and circumscribing a hexagon on a given circle;
        - (12) Inscribing an octagon in a given square;
        - (13) Constructing a circle through three given points not in a straight line;
        - (14) Constructing a circle of a given size tangent to a given line and passing through a given point;
        - (15) Constructing a circle tangent to a given line at a prescribed point on that line and passing through a given point not on that line;
        - (16) Constructing a circle of a given size tangent to a given circle and passing through a given point;

(17) Constructing an arc of a given size tangent to two given intersecting lines at acute or obtuse angles;
(18) Constructing a given size circle tangent to two given circles;
(19) Constructing an ellipse using the concentric circle method with major and minor diameters given;
(20) Construct an approximate ellipse with major and minor diameters given;

d. Demonstrate sketching techniques, including:
  (1) Isometric sketching;
  (2) Oblique sketching; and,
  (3) One-point and two-point perspective sketching.

3. The instructor will grade the student's performance on the student's ability to:
  a. Demonstrate use of drafting machine;
  b. Demonstrate use of drafting instruments;
  c. Demonstrate drafting techniques to create basic geometric elements, which include:
    (1) Bisecting a line or a circular arc;
    (2) Bisecting an angle and to transfer an angle;
    (3) Constructing a line parallel to a given line at a given distance;
    (4) Dividing a line into equal or proportional parts;
    (5) Constructing a triangle with the length of the sides given;
    (6) Inscribing a circle in a triangle;
    (7) Constructing a right triangle with hypotenuse and one side given;
    (8) Constructing a line through a point and perpendicular to a given line at the prescribed point and from a point off the given line;
    (9) Constructing a square with a side given;
    (10) Inscribing a regular pentagon in a given circle;
    (11) Inscribing and circumscribing a hexagon on a given circle;
    (12) Inscribing an octagon in a given square;
    (13) Constructing a circle through three given points not in a straight line;
    (14) Constructing a circle of a given size tangent to a given line and passing through a given point;
    (15) Constructing a circle tangent to a given line at a prescribed point on that line and passing through a given point not on that line;
    (16) Constructing a circle of a given size tangent to a given circle and passing through a given point;
    (17) Constructing an arc of a given size tangent to two given intersecting lines at acute or obtuse angles;
    (18) Constructing a given size circle tangent to two given circles;

(19) Constructing an ellipse using the concentric circle method with major and minor diameters given;
(20) Construct an approximate ellipse with major and minor diameters given;

d. Demonstrate sketching techniques, including:
(1) Isometric sketching;
(2) Oblique sketching; and,
(3) One-point and two-point perspective sketching.

TLD-C5-HO
Understand and Use Quality Systems
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Understand and apply quality principles, including continuous improvement; and,

b. Document paper trails for part revisions.

Module Outline:

I. Understand and Apply Quality Principles, Including Continuous Improvement
   A. Tolerances as basic quality control
   B. The technician as the first line of excellence
   C. Specific systems
      These systems are diverse. You, as the instructor, must tailor this portion of the lecture to the system used in your circumstances.
   D. The inspector as guarantor
   E. The consumer: the ultimate judge of top quality

II. ISO 9000
   A. Purpose
   B. What is ISO 9000?
   C. How does is work?
   D. Where do the standards come from?
   E. Who uses this stuff, anyway?

III. Document Paper Trails for Part Revisions

TOOL AND DIE MAKER .... skilled workers who produce tools, dies, and special guiding and holding devices that are used in machining.

Duties		Tasks												
A	**Practice Safety**	A-1 Follow safety manuals and all safety regulations/ requirements	A-2 Maintain safe equipment and machinery	A-3 Use safe operating procedures for hand and machine tools	A-4 Maintain a clean and safe work environment	A-5 Use safe material handling practices	A-6 Consult and apply MSDS for hazards of various materials							
B	**Apply Mathematical Concepts**	B-1 Perform basic arithmetic functions	B-2 Perform basic algebraic operations	B-3 Use basic geometric principles	B-4 Perform basic trigonometric functions	B-5 Use and apply Cartesian Coordinate System								
C	**Interpret Engineering Drawings and Related Documents**	C-1 Interpret and understand basic layout/types of drawings	C-2 Interpret, review, and apply blueprint notes, dimensions, and tolerances	C-3 Use and apply Geometric Dimensioning and Tolerancing (GD&T)	C-4 Demonstrate traditional mechanical drafting and sketching techniques	C-5 Understand and use quality systems								
D	**Demonstrate Knowledge of Manufacturing Materials**	D-1 Identify materials with desired properties	D-2 Identify materials and processes to produce a part	D-3 Discuss classification systems for metal										
E	**Measure/ Inspect**	E-1 Understand metrology terms	E-2 Select measurement tools	E-3 Measure with hand held instruments	E-4 Eliminate measurement variables	E-5 Measure/Inspect using surface plate and accessories	E-6 Inspect using stationary equipment							
F	**Demonstrate Knowledge of Manufacturing Processes**	F-1 Discuss metal cutting and metal cutting tools	F-2 Operate metal saws	F-3 Operate drill presses and tooling	F-4 Operate engine and turret lathes and tooling	F-5 Operate vertical and horizontal mills and tooling	F-6 Operate precision grinders	F-7 Operate heat treating equipment and processes	F-8 Operate sheet metal equipment	F-9 Operate welding equipment and processes	F-10 Estimate time required/ cost to produce a part			
G	**Use Computers**	G-1 Use computer operating systems	G-2 Understand computer terminology	G-3 Use file management systems	G-4 Install and use software packages									
H	**Perform CAD/ CAM and CNC Programming Tasks**	H-1 Discuss fundamentals of CNC machines and controls	H-2 Program and operate CNC milling machine and machining center	H-3 Program and operate CNC lathe	H-4 Use Computer-Aided Drafting (CAD) system	H-5 Create 3-D solid models	H-6 Use Computer-Aided Manufacturing (CAM) system							
I	**Perform Tool and Die Making Operations**	I-1 Discuss basic types and functions of jigs and fixtures	I-2 Utilize concepts of jig and fixture design	I-3 Demonstrate understanding of different types of industrial dies	I-4 Utilize basic die theory	I-5 Utilize principles of die design	I-6 Perform tool and die repair	I-7 Demonstrate tool and die making skills						
J	**Operate Electrical Discharge Machine (EDM)**	J-1 Discuss fundamentals of EDM	J-2 Setup and operate conventional sinker EDM	J-3 Program, setup, and operate CNC sinker EDM and EDM drill	J-4 Program, setup, and operate CNC wire EDM									

TLD-D1-HO1
Identify Materials with Desired Properties
Attachment 1: **MASTER** Handout No. 1

Objective(s):

Upon completion of this unit the student will be able to:

a. Discuss classification system for metals; and,

b. Describe general characteristics for carbon steels, tool steels, stainless steels, structural steels, cast irons, aluminum, and other commonly used metals.

Module Outline:

I. Discuss the Physical Properties of Metal
  A. Brittleness - the property of a metal which permits no permanent distortion before breaking
  B. Ductility - the ability of the metal to be permanently deformed without breaking
  C. Elasticity - the ability of a metal to return to its original shape after any force acting upon it has been removed
  D. Hardness - the resistance to forcible penetration
  E. Malleability - the property of a metal which permits it to be hammered or rolled into other sizes and shapes
  F. Tensile strength - the maximum amount of pull that a material will withstand before breaking
  G. Toughness - the property of a metal to withstand shock or impact

II. Discuss the Classification System for Steel
  A. Carbon steels
    1. Low carbon steel - contains from 0.02 to 0.20 percent of carbon
    2. Medium carbon steel - contains from 0.30 to 0.60 percent of carbon
    3. High carbon steel (tool steel) - contains over 0.60 percent of carbon
  B. Alloy steels - alloying elements allow steels to possess special characteristics
    Discuss Table 1.1 "Effects of Alloying Elements on Steel"
    Discuss Table 1.2 "SAE-ANSI Numerical Designation of Alloy Steels"

III. Describe General Characteristics For:
  A. Carbon Steels
  B. Tool Steels
  C. Stainless Steels
  D. Structural Steels
  E. Cast Irons

F. Non-Ferrous Metals
   1. Aluminum and Its Alloys
   2. Copper and Its Alloys
   3. Nickel Alloys
   4. Precious Metals
   5. Others

TLD-D1-HO2
Identify Materials With Desired Properties
Attachment 2: MASTER Handout No. 2

TABLES FOR TLD-D1 — PROPERTIES OF METALS
TABLE 1.1

THE EFFECT OF ALLOYING ELEMENTS ON STEEL

EFFECT	ELEMENT											
	Carbon	Chromium	Cobalt	Lead	Manganese	Molybdenum	Nickel	Phosphorus	Silicon	Sulfur	Tungsten	Vanadium
Increases tensile strength	X	X			X	X	X					
Increases hardness	X	X										
Increases wear resistance	X	X			X		X				X	
Increases hardenability	X	X			X	X	X					X
Increases ductility					X							
Increases elastic limit		X				X						
Increases rust resistance		X					X					
Increases abrasion resistance		X			X							
Increases toughness		X				X	X					X
Increases shock resistance		X					X					X
Increases fatigue resistance												X
Decreases ductility	X	X										
Decreases toughness			X									
Raises critical temperature		X	X								X	
Lowers critical temperature					X		X					
Causes hot shortness										X		
Causes cold shortness								X				
Imparts red hardness			X			X					X	
Imparts fine grain structure					X							X
Reduces deformation					X		X					
Acts as deoxidizer					X				X			
Acts as desulphurizer					X							
Imparts oil hardening properties		X			X	X	X					
Imparts air hardening properties					X	X						
Eliminates blow holes								X				
Creates soundness in casting									X			
Facilitates rolling and forging					X				X			
Improves machinability				X						X		

TLD-D1-HO3
Identify Materials With Desired Properties
Attachment 3: MASTER Handout No. 3

TABLE 1.2

SAE-AISI NUMERICAL DESIGNATION OF ALLOY STEELS
(X Represents Percent of Carbon in Hundredths)

Carbon Steels	
Plain carbon	10xx
Free-cutting, resulfurized	11xx
Manganese Steels	13xx
Nickel Steels	
.50% nickel	20xx
1.50% nickel	21xx
3.50% nickel	23xx
5.00% nickel	25xx
Nickel-Chromium Steels	
1.25% nickel, .65% chromium	31xx
1.75% nickel, 1.00% chromium	32xx
3.50% nickel, 1.57% chromium	33xx
3.00% nickel, .80% chromium	34xx
Corrosion and heat-resisting steels	303xx
Molybdenum Steels	
Chromium	41xx
Chromium-nickel	43xx
Nickel	46xx and 48xx
Chromium Steels	
Low-chromium	50xx
Medium-chromium	511xx
High-chromium	521xx
Chromium-Vanadium Steels	6xxx
Tungsten Steels	7xxx and 7xxxx
Triple-Alloy Steels	8xxx
Silicon-Manganese Steels	9xxx
Leaded steels	11Lxx (example)

TLD-D2-HO
Identify Materials and Processes to Produce a Part
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Briefly describe and list the advantages and disadvantages for each of the following: casting processes, hot working processes, and cold working processes;
b. Discuss service requirements (strength, hardness, etc.);
c. Discuss fastening processes (fasteners, welding, bonding, etc.); and,
d. Discuss corrosion resistance methods.

Module Outline:

I. Describe Casting Processes
    A. Discuss the following casting processes: sand, evaporative, shell molding, permanent mold, centrifugal, investment, and die casting
    B. Discuss pattern and mold design factors for each of the above casting processes
    C. List the advantages and disadvantages of the casting processes
II. Describe Hot Working Processes
    A. Discuss the following hot working processes: rolling, strand casting, forging, drawing, extrusion, spinning, and roll forming
    B. List the advantages and disadvantages of the hot working processes
III. Describe Cold Working Processes
    A. Discuss the following cold working processes: rolling, blanking, pressing, drawing, extruding, wire and bar drawing, bending, shearing, and roll forming
    B. List the advantages and disadvantages of the cold working process
IV. Evaluate Alternative Manufacturing Processes
    A. Discuss the powder metallurgy process (PM)
    B. Discuss the following nontraditional machining processes: EDM, laser machining, ultrasonic machining, hydrojet machining, electron beam machining, and plasma beam machining

TLD-D3-HO1
Discuss Classification Systems for Metal
Attachment 1: MASTER Handout No. 1

Objective(s):

Upon completion of this unit the student will be able to:

a. Identify organizations that classify metals;
b. Distinguish between types of metal by manufacturing method and/or shape;
c. Identify designation of each digit of a metal classification;
d. Identify carbon and alloy content of a metal using classification system;
e. Identify content of an unknown metal using shop tests; and,
f. Identify conformity of a metal to a specification system.

Module Outline:

I. Identify the Organizations That Classify Metals and Discuss the Significance of Each
    A. American Iron and Steel Institute (AISI)
    B. Society of Automotive Engineers (SAE)
    C. American Society for Testing and Materials (ASTM)
    D. American National Standards Institute (ANSI)
    E. Aluminum Association
II. Identify Classifications by Manufacturing Methods or Processes
    A. Hot rolled
    B. Cold rolled
    C. Turned and polished (sometimes referred to as ground and polished)
    D. Castings
    E. Forgings
    F. Galvanized
III. Identify Classifications by Shape
    A. Sheet and plate
    B. Bar stock
    C. Pipe and tubing
    D. Rod and wire
    E. Coil or strip
    F. Structural steel
IV. Discuss the AISI-SAE Numbering Systems for Carbon Steels
    A. Plain carbon steels (AISI-SAE 10xx and 15xx)
    B. Free-cutting steels (AISI-SAE 11xx and 12xx)
V. Discuss the AISI-SAE Classification Systems for Alloy Steels
    A. Manganese steels (AISI-SAE 13xx)

    - B. Nickel steels (AISI-SAE 2xxx)
    - C. Nickel-chromium steels (AISI-SAE 3xxx)
    - D. Molybdenum steels (AISI-SAE 4xxx)
    - E. Low chromium steels (AISI-SAE 5xxx)
    - F. Other alloy steels (AISI-SAE 61xx, 8xxx, and 9xxx)
- VI. Discuss the AISI-SAE Classification of Stainless Steels
    - A. Chromium-nickel austenitic steels (SAE 30xxx or AISI 20x and 3xx)
    - B. Ferritic chromium steels (SAE 51xxx or AISI 4xx and 50x)
    - C. Martensitic chromium steels (SAE 51xxx or AISI 4xx and 50x)
- VII. Discuss the AISI Classification of Tool Steels
    - A. High speed tool steels (AISI type M and T)
    - B. Hot work tool steels (AISI type H)
    - C. Cold work tool steels (AISI type D, A, and O)
    - D. Shock resisting tool steels (AISI type S)
    - E. Mold steels (AISI type P)
    - F. Special purpose tool steels (AISI type L and F)
    - G. Water hardening tool steels (AISI type W)
- VIII. Discuss the Classification of Nonferrous Alloys
    - A. Aluminum and aluminum alloys (Aluminum Association four digit system)
    - B. Magnesium alloys (SAE type 5x and 5xx)
    - C. Nickel and nickel alloys (by name)
    - D. Titanium and titanium alloys (titanium and chief alloying element)
    - E. Copper and copper alloys (by name and SAE standard number)
- IX. Discuss the Classification of Castings
    - A. Brass and bronze castings (SAE standard number)
    - B. Aluminum casting alloys (Aluminum Association four digit system)
    - C. Cast Iron (ASTM grade)
    - D. Steel Castings (ASTM grade)
- X. Discuss the Unified Numbering System (UNS) for Metals and Alloys
- XI. Discuss the Basic Identification of an Unmarked Piece of Steel Using Shop Tests
    - A. Observation
    - B. Magnet test
    - C. Hardness test
    - D. Scratch test
    - E. File test
    - F. Chemical test
    - G. Spark test
- XII. Identify Specification Systems for Metals and Alloys
    - A. American Society for Testing and Materials (ASTM)
    - B. American National Standards Institute (ANSI)
    - C. U.S. Department of Defense (military specifications)
    - D. General Accounting Office (federal specifications)

TLD-D3-HO2
Discuss Classification Systems for Metal
Attachment 2: MASTER Handout No. 2

AISI-SAE STANDARD STEELS CLASSIFICATION

AISI-SAE	Type of Steel and Nominal Alloy Content
	Carbon Steels
10xx	Plain Carbon (Max 1% Mn.)
15xx	Plain Carbon (Max 1% - 1.65% Mn.)
11xx	Free Cutting, Resulfurized
12xx	Free Cutting, Resulfurized and Rephosporized
	Manganese Steels
13xx	1.75% Manganese
	Nickel Steels
23xx	3.50% Nickel
25xx	5.00% Nickel
	Nickel-Chromium Steels
31xx	1.25% Nickel; 0.65% and 0.80% Chromium
32xx	1.75% Nickel; 1.07% Chromium
33xx	3.50% Nickel; 1.50% and 1.57% Chromium
34xx	3.00% Nickel; 0.77% Chromium
	Molybdenum Steels
40xx	0.20% and 0.25% Molybdenum
44xx	0.40% and 0.52% Molybdenum
	Chromium-Molybdenum Steels
41xx	0.50% - 0.95% Chromium; 0.12% - 0.30% Molybdenum
	Nickel-Molybdenum Steels
46xx	0.85% and 1.82% Nickel; 0.20% and 0.25% Molybdenum
48xx	3.50% Nickel; 0.25% Molybdenum
	Chromium Steels
50xx	0.27% - 0.65% Chromium
51xx	0.80% - 1.05% Chromium
50xxx	0.50% Chromium; Min. 1.00% Carbon
51xxx	1.02% Chromium; Min. 1.00% Carbon
52xxx	1.45% Chromium; Min. 1.00% Carbon
	Chromium-Vanadium Steels
61xx	0.60% - 0.95% Chromium; 0.10% and 0.15% Vanadium
	Tungsten-Chromium Steels
72xx	1.75% Tungsten; 0.75% Chromium
	Triple Alloy Steels
43xx	1.82% Nickel; 0.50% and 0.80% Chromium; 0.25% Molybdenum
47xx	1.05% Nickel; 0.45% Chromium; 0.20% and 0.35% Molybdenum
8xxx	0.30% - 0.55% Nickel; 0.40% - 0.50% Chromium; 0.12% - 0.35% Molybdenum
92xx	1.40% and 2.00% Silicon; 0.00% and 0.65% Chromium; 0.65% - 0.85% Manganese
93xx	3.25% Nickel; 1.20% Chromium; 0.12% Molybdenum
94xx	0.45% Nickel; 0.40% Chromium; 0.12% Molybdenum
98xx	1.00% Nickel; 0.80% Chromium; 0.25% Molybdenum

AISI	SAE	Stainless Steel
2xx	302xx	Austenitic Steels; 16% - 19% Chromium; 1% - 5.5% Nickel
3xx	303xx	Austenitic Steels; 16% - 21% Chromium; 6% - 15% Nickel
4xx	514xx	Ferritic or Martensitic Steels; 10.5% - 18% Chromium
5xx	515xx	Ferritic or Martensitic Steels; 4% - 6% Chromium

TLD-D3-HO3
Discuss Classification Systems for Metal
Attachment 3: MASTER Handout No. 3

AISI TOOL STEELS CLASSIFICATION

CATEGORY DESIGNATION	AISI	GROUP DESIGNATION
High Speed Tool Steels	M T	Molybdenum Types Tungsten Types
Hot Work Tool Steels	H1 - H19 H20 - H39 H40 - H59	Chromium Types Tungsten Types Molybdenum Types
Cold Work Tool Steels	D A O	High Carbon, High Chromium Types Medium Alloy, Air Hardening Types Oil Hardening Types
Shock Resisting Tool Steels	S	- - - - -
Mold Steels	P	- - - - -
Special Purpose Tool Steels	L F	Low Alloy Types Carbon Tungsten Types
Water Hardening Tool Steels	W	- - - - -

UNIFIED NUMBERING SYSTEM (UNS) FOR METALS & ALLOYS

UNS SERIES	METAL
Nonferrous Metals and Alloys	
A00001 to A99999	Aluminum and Aluminum Alloys
C00001 to C99999	Copper and Copper Alloys
E00001 to E99999	Rare Earth and Rare Earth-Like Metals and Alloys
L00001 to L99999	Low Melting Metals and Alloys
M00001 to M99999	Miscellaneous Nonferrous Metals and Alloys
P00001 to P99999	Precious Metals and Alloys
R00001 to R99999	Reactive and Refractory Metals and Alloys
Z00001 to Z99999	Zinc and Zinc Alloys
Ferrous Metals and Alloys	
D00001 to D99999	Specified Mechanical Property Steels
F00001 to F99999	Cast Irons
G00001 to G99999	AISI and SAE Carbon and Alloy Steels (Except Tool Steels)
H00001 to H99999	AISI H-Steels
J00001 to J99999	Cast Steels (Except Tool Steels)
K00001 to K99999	Miscellaneous Steels and Ferrous Alloys
S00001 to S99999	Heat and Corrosion Resistant (Stainless Steels)
T00001 to T99999	Tool Steels

TLLD-D3-HO4
Discuss Classification Systems for Metal
Attachment 4: MASTER Handout No. 4
EXAMPLE OF A SPECIFICATION

HOT ROLLED CARBON STEEL BARS							
Size	Tolerance		Out-of-Section	Size	Tolerance		Out-of-Section
	Plus	Minus			Plus	Minus	
Rounds, Squares and Round-Cornered Squares							
To 5/16	.005	.005	.008	Over 1-1/2 to 2	1/64	1/64	.023
Over 5/16 to 7/16	.006	.006	.009	Over 2 to 2-1/2	1/32	0	.023
Over 7/16 to 5/8	.007	.007	.010	Over 2-1/2 to 3-1/2	3/64	0	.035
Over 5/8 to 7/8	.008	.008	.012	Over 3-1/2 to 4-1/2	1/16	0	.046
Over 7/8 to 1	.009	.009	.013	Over 4-1/2 to 5-1/2	5/64	0	.058
Over 1 to 1-1/8	.010	.010	.015	Over 5-1/2 to 6-1/2	1/8	0	.070
Over 1/18 to 1-1/4	.011	.011	.016	Over 6-1/2 to 8-1/4	5/32	0	.085
Over 1-1/4 to 1-38	.012	.012	.018	Over 8-1/4 to 9-1/2	3/16	0	.100
Over 1-3/8 to 1-1/2	.014	.014	.021	Over 9-1/2 to 10	1/4	0	.120
Hexagons							
To 1/2	.007	.007	.011	Over 1-1/2 to 2	1/32	1/64	1/32
Over 1/2 to 1	.010	.120	.015	Over 2 to 2-1/2	3/64	1/64	3/64
Over 1 to 1-1/2	.021	.130	.025	Over 2-1/2 to 3-1/2	1/16	1/64	1/16

COLD FINISHED CARBON STEELS							
Size	Max. % Carbon			Size	Max. % Carbon		
	Up to .28	Over .28 to .55	Over .55		Up to .28	Over .28 to .55	Over .55
	Minus Tolerance				Minus Tolerance		
Cold Drawn Rounds				Cold Drawn Flats			
To 1-1/2	.002	.003	.005	To 3/4	.003	.004	.008
Over 1-1/2 to 2-1/2	.003	.004	.006	Over 3/4 to 1-1/2	.004	.005	.010
Over 2-1/2 to 4	.004	.005	.007	Over 1-1/2 to 3	.005	.006	.012
Over 4 to 6	.005	.006	.008	Over 3 to 4	.006	.008	0.016
				Over 4 to 6	.008	.010	.020
				Over 6	.013	.015	-----
Cold Drawn Hexagons				Cold Drawn Squares			
To 3/4	.002	.003	.006	To 3/4	.002	.004	.007
Over 3/4 to 1-1/2	.003	.004	.007	Over 3/4 to 1-1/2	.003	.005	.008
Over 1-1/2 to 2-1/2	.004	.005	.008	Over 1-1/2 to 2-1/2	.004	.006	.009
Over 2-1/2 to 3-1/8	.005	.006	.009	Over 2-1/2 to 4	.005	.008	.011
Turned and Polished Rounds							
To 1-1/2	.002	.003	.005	Over 4 to 6	.005	.006	.008
Over 1-1/2 to 2-1/2	.003	.004	.006	Over 6 to 8	.006	.007	.009
Over 2-1/2 to 4	.004	.005	.007	Over 8 to 9	.007	.008	.010

TLD-D3-LA
Discuss Classification Systems for Metal
Attachment 5: MASTER Laboratory Aid

List of Materials for Shop Tests and Illustration

1. **Observation Test**
   Sample of round bars with various surface finishes (cold finished, hot rolled, ground and polished)

2. **Magnet Test**
   Sample of carbon steel, ferritic or martensitic stainless steel, austenitic stainless steel, aluminum, and nickel steel

3. **Hardness Test**
   Sample of mild steel, medium carbon steel, high carbon steel, alloy steel, and tool steel

4. **Scratch Test**
   Sample of mild steel, medium carbon steel, high carbon steel, alloy steel, and tool steel

5. **File Test**
   Sample of mild steel, medium carbon steel, high carbon steel, alloy steel, and tool steel

6. **Chemical Test**
   Sample of carbon steel, type 302 or 304 stainless steel, type 316 or 317 stainless steel

7. **Spark Test**
   Sample of low carbon steel, high carbon steel, cast iron, high speed steel, tool steel, and manganese steel

8. **Observation Test**
   Samples of bar stock (round and square), hot rolled sheet, cold finished coil strip, galvanized sheet, small diameter pipe, small diameter tubing, small gauge wire, hot rolled rod, and cold finished rod

TLD-D3-LW
Discuss Classification Systems for Metal
Attachment 6: MASTER Laboratory Worksheet

I. Identify the following:

a. AISI
b. SAE
c. ASTM
d. ANSI
e. UNS

II. Complete the following charts:

A. Standard Steels and Alloy Steels

	AISI-SAE	APP. % CARBON	MAJOR ALLOYING ELEMENTS
Ex.	1020	.20	Only Carbon
Ex.	6118	.18	Chromium & Vanadium
Ex.	4340	.40	Nickel, Chromium, Molybdenum
1.	1040		
2.	1095		
3.	1212		
4.	1340		
5.	2340		
6.	2512		
7.	3140		
8.	3310		
9.	4024		
10.	4140		
11.	4320		
12.	4620		
13.	5135		
14.	52100		
15.	6150		

B. AISI-SAE-UNS Classification System

	AISI-SAE	UNS	TYPE METAL OR STEEL
Ex.	1212	G12120	Free Cutting Carbon Steel
Ex.	48xx	G48xx0	Nickel- Molybdenum Steel
Ex.	A6	T30106	Air Harden Cold Work Tool Steel
1.	1527		
2.	1151		
3.		G10290	
4.		G41xx0	
5.		G61500	
6.			Tungsten-Chromium Steels
7.			Austenitic Stainless Steels
8.			Nickel Steels
9.	H21	T20821	
10.		T12002	Tungsten High Speed Tool Steels
11.	Sx	T4190x	
12.	D2	T30402	
13.		T41906	Shock Resisting Tool Steels
14.	-----	Axxxxx	
15.			Copper and Copper Alloy

III. Answer the following questions:

A.. What is the out-of-round tolerance for 2-1/2" diameter hot rolled bar?

____

____

B. What is the size tolerance for 1-3/4" cold finished hexagon bar made from 1045?

____

____

C. If the only requirements given you were 1" 1018 square bar with a size tolerance of -.006, would you choose hot rolled (much cheaper) or cold finished stock?

____

____

IV. Record the results of your shop test below.

Item No.	Test Used	Kind of Metal
1.		
2.		
3.		
4.		
5.		

TOOL AND DIE MAKER .... skilled workers who produce tools, dies, and special guiding and holding devices that are used in machining.

Duties ← **Tasks** →

A	**Practice Safety**	A-1 Follow safety manuals and all safety regulations/ requirements	A-2 Maintain safe equipment and machinery	A-3 Use safe operating procedures for hand and machine tools	A-4 Maintain a clean and safe work environment	A-5 Use safe material handling practices	A-6 Consult and apply MSDS for hazards of various materials							
B	**Apply Mathematical Concepts**	B-1 Perform basic arithmetic functions	B-2 Perform basic algebraic operations	B-3 Use basic geometric principles	B-4 Perform basic trigonometric functions	B-5 Use and apply Cartesian Coordinate System								
C	**Interpret Engineering Drawings and Related Documents**	C-1 Interpret and understand basic layout/types of drawings	C-2 Interpret, review, and apply blueprint notes, dimensions, and tolerances	C-3 Use and apply Geometric Dimensioning and Tolerancing (GD&T)	C-4 Demonstrate traditional mechanical drafting and sketching techniques	C-5 Understand and use quality systems								
D	**Demonstrate Knowledge of Manufacturing Materials**	D-1 Identify materials with desired properties	D-2 Identify materials and processes to produce a part	D-3 Discuss classification systems for metal										
E	**Measure/ Inspect**	E-1 Understand metrology terms	E-2 Select measurement tools	E-3 Measure with hand held instruments	E-4 Eliminate measurement variables	E-5 Measure/inspect using surface plate and accessories	E-6 Inspect using stationary equipment							
F	**Demonstrate Knowledge of Manufacturing Processes**	F-1 Discuss metal cutting and metal cutting tools	F-2 Operate metal saws	F-3 Operate drill presses and tooling	F-4 Operate engine and turret lathes and tooling	F-5 Operate vertical and horizontal mills and tooling	F-6 Operate precision grinders	F-7 Operate heat treating equipment and processes	F-8 Operate sheet metal equipment	F-9 Operate welding equipment and processes	F-10 Estimate time required/ cost to produce a part			
G	**Use Computers**	G-1 Use computer operating systems	G-2 Understand computer terminology	G-3 Use file management systems	G-4 Install and use software packages									
H	**Perform CAD/ CAM and CNC Programming Tasks**	H-1 Discuss fundamentals of CNC machines and controls	H-2 Program and operate CNC milling machine and machining center	H-3 Program and operate CNC lathe	H-4 Use Computer-Aided Drafting (CAD) system	H-5 Create 3-D solid models	H-6 Use Computer-Aided Manufacturing (CAM) system							
I	**Perform Tool and Die Making Operations**	I-1 Discuss basic types and functions of jigs and fixtures	I-2 Utilize concepts of jig and fixture design	I-3 Demonstrate understanding of different types of industrial dies	I-4 Utilize basic die theory	I-5 Utilize principles of die design	I-6 Perform tool and die repair	I-7 Demonstrate tool and die making skills						
J	**Operate Electrical Discharge Machine (EDM)**	J-1 Discuss fundamentals of EDM	J-2 Setup and operate conventional sinker EDM	J-3 Program, setup, and operate CNC sinker EDM and EDM drill	J-4 Program, setup, and operate CNC wire EDM									

TLD PM
[illegible]

TLD-E1-HO
Understand Metrology Terms
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:
- a. Discuss the use of metrology in manufacturing;
- b. Discuss the Inch system of measurement;
- c. Discuss the Metric system of measurement;
- d. Discuss semi-precision and precision measurement; and,
- e. Discuss the following: precision, reliability, discrimination, and accuracy.

Module Outline:

- I. Discuss the Use of Metrology in Manufacturing
  - A. Discuss the function and reason for measurements in manufacturing
  - B. Discuss the changes (metrology related) in manufacturing today
    - 1. Interchangeable manufacture
    - 2. World trade
    - 3. High precision
- II. Discuss the Inch System of Measurement
  - A. Discuss fractional (scale) dimensions for linear measurement
  - B. Discuss decimal dimensions for linear measurement
  - C. Convert fractional to decimal
    - 1. Review mathematical conversion method
    - 2. Fractional/decimal conversion charts
  - D. Practice and demonstration of skills listed above
- III. Discuss the Metric System of Measurement
  - A. Discuss the units of measure commonly used in the metric system
  - B. Convert inch to metric
    - 1. Review mathematical method (1 inch = 25.4 mm)
    - 2. Conversion charts
  - C. Practice and demonstration of skills listed above
- IV. Discuss Semi-Precision and Precision Measurement
  - A. Discuss the difference between semi-precision and precision measurement
    - 1. Semi-precision measurements are 1/64" (.5mm) or greater
    - 2. Precision measurements are less than 1/64" (.5mm)
  - B. Discuss the five categories of precision measurement
    - 1. Outside measurement
    - 2. Inside measurement
    - 3. Depth measurement

        4. Thread measurement
        5. Height measurement

V. Discuss the Following Measurement Terms: Accuracy, Precision, Reliability, and Discrimination
    A. *Accuracy* - whether or not something is made according to standard. (The standard for manufacturing is the blueprint.)
    B. *Precision* - the degree of exactness required for an application or design requirement
    C. *Reliability* - the ability to consistently obtain the desired result
    D. *Discrimination* - the degree that a measuring instrument divides its basic unit of length

TLD-E2-HO
Select Measurement Tools
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Identify basic semi-precision measuring tools;
b. Identify precision measuring tools;
c. Justify use of particular measurement tools based on tool characteristics;
d. Identify error possibilities in measurement tool selection; and,
e. Demonstrate proper care of precision measuring tools.

Module Outline:

I. Describe and Discuss the Following Semi-Precision Measuring Tools
   A. Steel rules
   B. Calipers
   C. Squares
II. Describe and Discuss the Following Precision Measuring Tools
   A. Micrometers (outside, inside and depth)
   B. Verniers (calipers and height gage)
   C. Gages (small hole, telescope, fixed, and dial bore)
III. Justify Use of Particular Measurement Tools Based on Tool Characteristics
   A. What tolerance is required by the print?
   B. What physical characteristics of the part influence tool selection?
   C. What is the discrimination of the tool?
   D. How much time is available for part measurement/inspection?
   E. Will the tool be used by itself or in conjunction with some other tool?
   F. What is the most reliable tool for this application?
IV. Identify Error Possibilities in Measurement Tool Selection
   A. Part not being produced to specifications
   B. Too much time spent trying to measure correctly by not having the right tool
V. Demonstrate Proper Care of Precision Measuring Tools
   A. Storage
   B. Handling
   C. Cleaning

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and,
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

TLD-E3-HO
Measure With Hand Held Instruments
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

- a. Measure with steel rules (metric and inch);
- b. Measure with micrometers;
- c. Measure with comparison measuring instruments (e.g., calipers, telescope gages);
- d. Measure with direct measuring instruments (e.g., vernier, dial and digital instruments); and,
- e. Measure with fixed gages (go and no-go gages).

Module Outline:

- I. Discuss the Importance of Learning and Practicing Proper Measurement Techniques
  - A. Show the video "Measuring Tools"
  - B. Give each student a copy of the handout "Proper Measuring Techniques"
- II. Discuss and Demonstrate Proper Measurement Techniques Using the Steel Rule
- III. Discuss and Demonstrate the Use of Micrometer Type Measuring Instruments
  - A. Outside micrometers
  - B. Inside micrometers
  - C. Depth micrometers
  - D. Practice and demonstration of skills listed above
- IV. Discuss and Demonstrate the Use of Transfer Type Measuring Instruments
  - A. Spring calipers (inside and outside)
  - B. Telescope gages
  - C. Small hole gages
  - D. Practice and demonstration of skills listed above
- V. Discuss and Demonstrate the Use of Direct Measuring Instruments
  - A. Vernier calipers
  - B. Dial calipers
  - C. Digital calipers
  - D. Practice and demonstration of skills listed above
- VI. Discuss the Purpose of Fixed Gages and Demonstrate Their Use
  - A. Cylindrical plug and ring gages
  - B. Taper plug and ring gages
  - C. Snap gages

  - D. Thread plug gages
  - E. Practice and demonstration of skills listed above

VII. Complete Practical Exercise (TLD-E3-LE1) and (TLD-E3-LE2) On All the Above Material

Name:________________ Date:______________________

TLD-E3-LE1
Measure With Hand Held Instruments
Attachment 2: MASTER Laboratory Exercise No. 1

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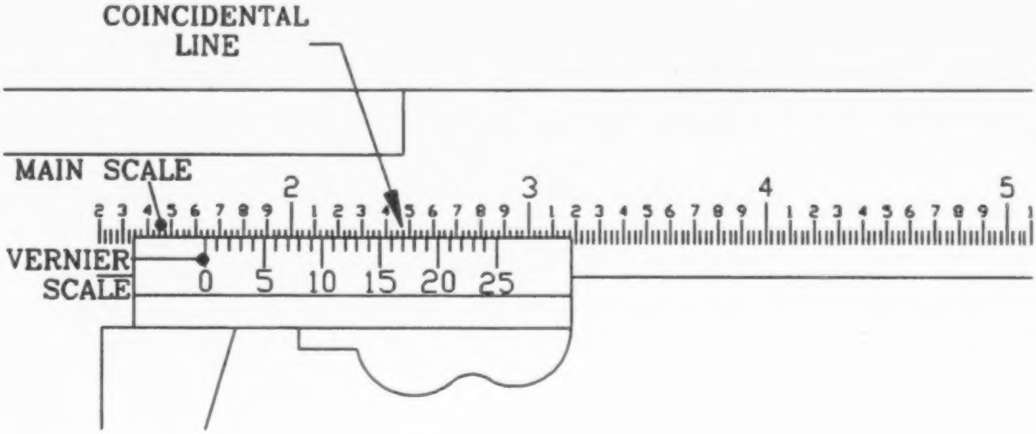
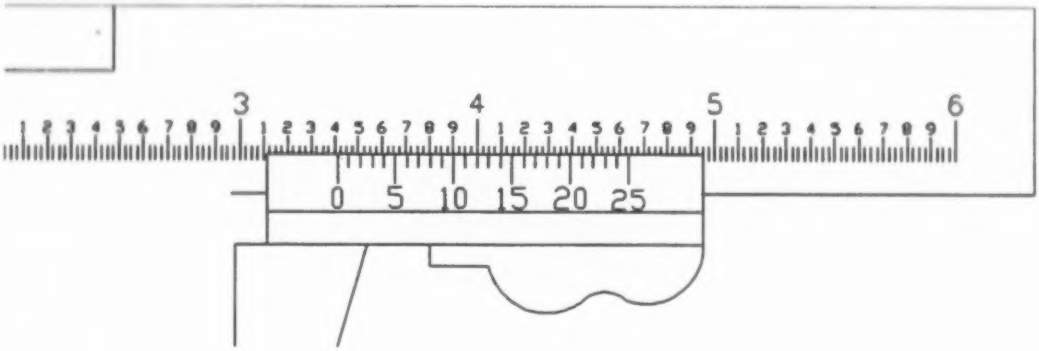
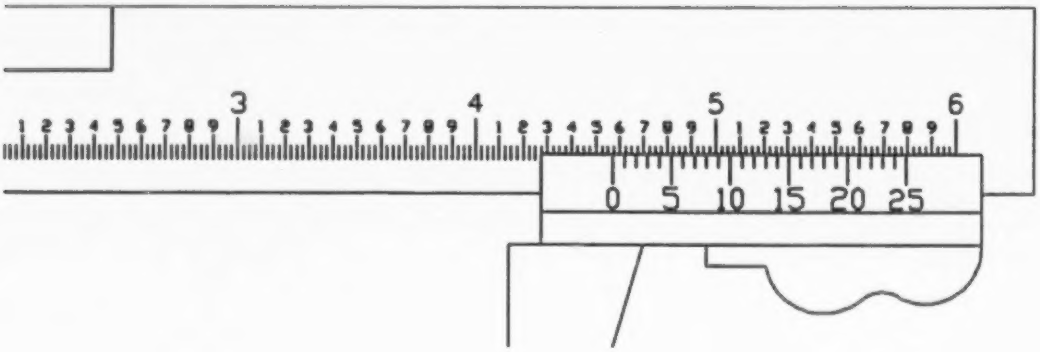
1. What is the reading on the vernier caliper below?
   - a. .642
   - b. 1.642
   - c. 1.645
   - d. 1.64


COINCIDENTAL LINE
MAIN SCALE
2
3
4
5
2 3 4 5 6 7 8 9 1 2 3 4 5 6 7 8 9 1 2 3 4 5 6 7 8 9 1 2 3 4 5 6 7 8 9 1
VERNIER SCALE
0 5 10 15 20 25

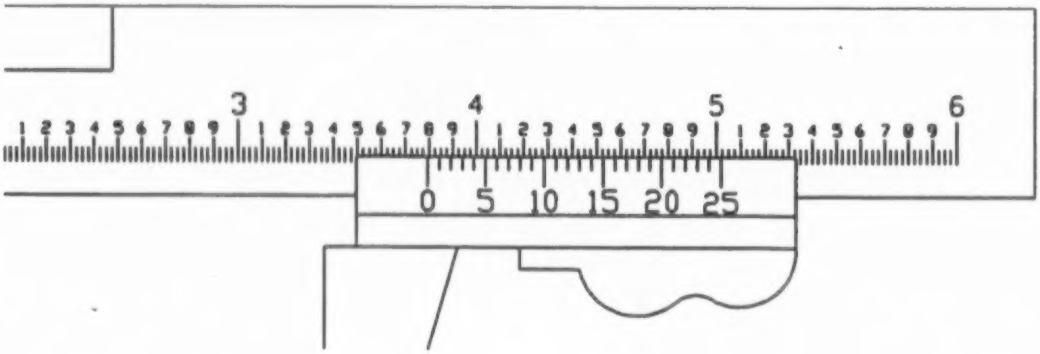
2. What is the reading on the vernier caliper below?
   - a. .415
   - b. 3.125
   - c. 3.405
   - d. 3.412


3
4
5
6
1 2 3 4 5 6 7 8 9 1 2 3 4 5 6 7 8 9 1 2 3 4 5 6 7 8 9 1 2 3 4 5 6 7 8 9
0 5 10 15 20 25

3. What is the reading on the vernier caliper below?
   a. 4.575
   b. 4.250
   c. 4.570
   d. 4.275


3
4
5
6
1 2 3 4 5 6 7 8 9
0 5 10 15 20 25

4. What is the reading on this vernier caliper?
   a. 3.785
   b. 3.800
   c. 3.473
   d. 3.793


3
4
5
6
1 2 3 4 5 6 7 8 9
0 5 10 15 20 25

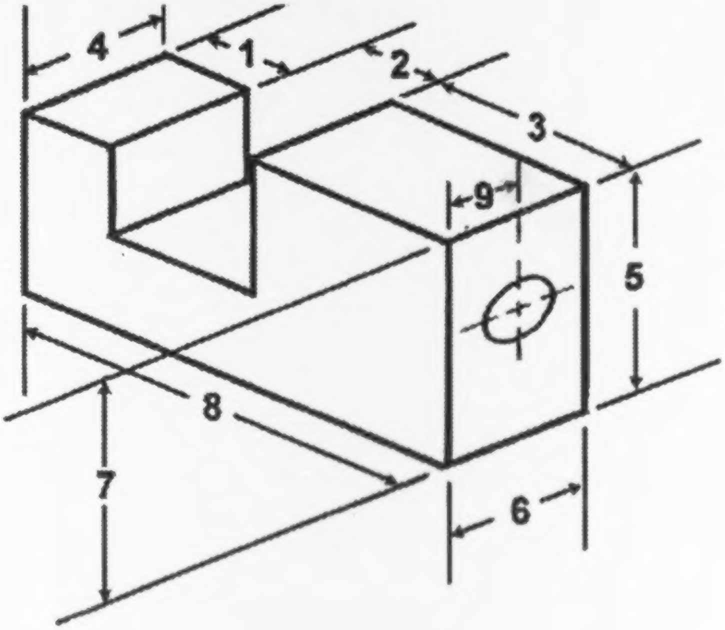
Name______________________________ Date_________________

TLD-E3-LE2

Measure With Hand Held Instruments

Attachment 3: **MASTER** Laboratory Exercise No. 2

Using the measuring instruments provided for you and the measuring specimens, measure for the following dimensions and record your answers in the space provided. Be sure to provide metric and inch answers for each dimension. Turn this sheet in to your instructor for evaluation.



Specimen Number _______

Dimension	metric	inch	Dimension	metric	inch
1.	_____	_____	7.	_____	_____
2.	_____	_____	8.	_____	_____
3.	_____	_____	9.	_____	_____
4.	_____	_____	10.	_____	_____
5.	_____	_____	11.	_____	_____
6.	_____	_____			

Rules of Conduct

1. **Absolutely no horseplay or practical joking will be tolerated.**
2. **Do not talk to anyone who is operating a machine.**
3. **Walk only in the designated traffic lanes.**
4. **Dress appropriately; at the absolute minimum, you must have:**
    a. **No loose clothing, including ties;**
    b. **Long hair properly stowed;**
    c. **No jewelry;**
    d. **Hard, closed-toe shoes;**
    e. **Eye protection (safety glasses); and,**
    f. **Ear protection (plugs or headset).**
5. Follow all institutional safety rules.

TLD-E4-HO
Eliminate Measurement Variables
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Discuss factors affecting accurate measurement (dirt, temperature, improper measuring tool calibration);
b. Explain calibration requirements of various precision instruments;
c. Illustrate measurement differences when taken with calibrated and non-calibrated instruments; and,
d. Calibrate a micrometer type measuring tool.

Module Outline:

I. Discuss Factors Affecting Accurate Measurement
  A. Tool selection
  B. Cleanliness
  C. Temperature
  D. Calibration
  E. "Feel"
II. Explain Calibration Requirements of Various Precision Instruments
  A. Individual responsibility vs. company responsibility
  B. Calibration standards
III. Illustrate Measurement Differences When Taken With Calibrated and Non-Calibrated Instruments
IV. Calibrate a Micrometer Type Measuring Tool
  A. 5 steps adjusting an outside micrometer which needs adjustment
    1. Clean the measuring faces of the micrometer
    2. Close the measuring faces carefully against the standard by turning the ratchet stop or friction thimble
    3. Insert the C-spanner into the hole or slot provided in the sleeve
    4. Carefully turn the sleeve until the index line on the sleeve coincides with the zero line on the thimble
    5. Recheck the accuracy of the micrometer by opening and then closing the micrometer faces by turning the ratchet stop or friction thimble
  B. Student practice of the above procedure

TLD-E4-LE
Eliminate Measurement Variables
Attachment 2: MASTER Laboratory Exercise

The student will perform the following:

1. Calibrate a micrometer by:
    a. Adjusting micrometer;
    b. Cleaning the measuring faces of the micrometer;
    c. Closing the measuring faces carefully against the standard by turning the ratchet stop or friction thimble;
    d. Inserting the C-spanner into the hole or slot provided in the sleeve;
    e. Carefully turning the sleeve until the index line on the sleeve coincides with the zero line on the thimble; and,
    f. Rechecking the accuracy of the micrometer by opening and then closing the micrometer faces by turning the ratchet stop or friction thimble.

TLD-E4-LA
Eliminate Measurement Variables
Attachment 3: MASTER Laboratory Aid

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and,
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

TLD-E5-HO
Measure/Inspect Using Surface Plate and Accessories
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Describe care of surface plate;
b. Use surface plate accessories correctly (sine bar, gage blocks, etc.);
c. Check for part squareness;
d. Check part dimensions for accuracy; and,
e. Align workpieces using height gage and dial indicators.

Module Outline:

I. Describe Types of Surface Plate and Surface Tables
  A. Cast iron and semi-steel surface plates
  B. Granite surface plate
II. Discuss the Different Surface Plate Accessories and Their Use
  A. Sine bar
  B. Gage blocks
  C. Vernier height gage
  D. Precision height gage
  E. Dial test indicator
  F. Squares
  G. Angle plate and clamps
  H. 1,2,3 blocks
III. Demonstrate Checking For Part Squareness
IV. Demonstrate Checking Part Dimensions For Accuracy
V. Demonstrate Aligning Workpieces Using Height Gage and Dial Indicators

TLD-E5-LE
Measure/Inspect Using Surface Plate and Accessories
Attachment 2: MASTER Laboratory Exercise

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1. Instructor will provide sample mechanical parts for students to:
   a. Demonstrate checking for part squareness;
   b. Demonstrate checking part dimensions for accuracy; and,
   c. Demonstrate aligning workpieces using height gage and dial indicators.

2. Students will practice:
   a. Checking for part squareness;
   b. Checking part dimensions for accuracy; and,
   c. Aligning workpieces using height gage and dial indicators.

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

TLD-E6-HO
Inspect Using Stationary Equipment
Attachment 1: **MASTER** Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Set up and use an Optical Comparator; and,
b. Set up and use a Coordinate Measuring Machine (CMM).

Module Outline:

I. Define the Term "Comparison Measurement"
  A. Describe the following comparison instruments:
    1. Dial indicator
    2. Mechanical comparator
    3. Optical comparator
    4. Mechanical-optical comparator
    5. Air gages
    6. Electronic comparator
  B. Demonstrate the setup and operation of the optical comparator
  C. Allow students to practice setup and operation of the optical comparator
II. Discuss the Advantages of Measuring with the Coordinate Measuring Machine (CMM)
  A. Demonstrate the setup and operation of the CMM
  B. Allow students to practice setup and operation of the CMM

TLD-E6-LE
Inspect Using Stationary Equipment
Attachment 2: MASTER Laboratory Exercise

---

1. The instructor will:
   a. Demonstrate the setup and operation of the optical comparator; and,
   b. Demonstrate the setup and operation of the Coordinate Measuring Machine (CMM).

2. The students will:
   a. Practice the setup and operation of the optical comparator; and,
   b. Practice the setup and operation of the Coordinate Measuring Machine (CMM).

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and,
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

TOOL AND DIE MAKER .... skilled workers who produce tools, dies, and special guiding and holding devices that are used in machining.

	Duties	Tasks												
A	Practice Safety	A-1 Follow safety manuals and all safety regulations/ requirements	A-2 Maintain safe equipment and machinery	A-3 Use safe operating procedures for hand and machine tools	A-4 Maintain a clean and safe work environment	A-5 Use safe material handling practices	A-6 Consult and apply MSDS for hazards of various materials							
B	Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Perform basic algebraic operations	B-3 Use basic geometric principles	B-4 Perform basic trigonometric functions	B-5 Use and apply Cartesian Coordinate System								
C	Interpret Engineering Drawings and Related Documents	C-1 Interpret and understand basic layout/types of drawings	C-2 Interpret, review, and apply blueprint notes, dimensions, and tolerances	C-3 Use and apply Geometric Dimensioning and Tolerancing (GD&T)	C-4 Demonstrate traditional mechanical drafting and sketching techniques	C-5 Understand and use quality systems								
D	Demonstrate Knowledge of Manufacturing Materials	D-1 Identify materials with desired properties	D-2 Identify materials and processes to produce a part	D-3 Discuss classification systems for metal										
E	Measure/ Inspect	E-1 Understand metrology terms	E-2 Select measurement tools	E-3 Measure with hand held instruments	E-4 Eliminate measurement variables	E-5 Measure/inspect using surface plate and accessories	E-6 Inspect using stationary equipment							
F	Demonstrate Knowledge of Manufacturing Processes	F-1 Discuss metal cutting and metal cutting tools	F-2 Operate metal saws	F-3 Operate drill presses and tooling	F-4 Operate engine and turret lathes and tooling	F-5 Operate vertical and horizontal mills and tooling	F-6 Operate precision grinders	F-7 Operate heat treating equipment and processes	F-8 Operate sheet metal equipment	F-9 Operate welding equipment and processes	F-10 Estimate time required/ cost to produce a part			
G	Use Computers	G-1 Use computer operating systems	G-2 Understand computer terminology	G-3 Use file management systems	G-4 Install and use software packages									
H	Perform CAD/ CAM and CNC Programming Tasks	H-1 Discuss fundamentals of CNC machines and controls	H-2 Program and operate CNC milling machine and machining center	H-3 Program and operate CNC lathe	H-4 Use Computer-Aided Drafting (CAD) system	H-5 Create 3-D solid models	H-6 Use Computer-Aided Manufacturing (CAM) system							
I	Perform Tool and Die Making Operations	I-1 Discuss basic types and functions of jigs and fixtures	I-2 Utilize concepts of jig and fixture design	I-3 Demonstrate understanding of different types of industrial dies	I-4 Utilize basic die theory	I-5 Utilize principles of die design	I-6 Perform tool and die repair	I-7 Demonstrate tool and die making skills						
J	Operate Electrical Discharge Machine (EDM)	J-1 Discuss fundamentals of EDM	J-2 Setup and operate conventional sinker EDM	J-3 Program, setup, and operate CNC sinker EDM and EDM drill	J-4 Program, setup, and operate CNC wire EDM									

Duty F

TLD-F1-HO
Discuss Metal Cutting and Metal Cutting Tools
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

- a. Discuss physics of metal cutting
- b. Discuss cutting tools
- c. Discuss cutting fluids and coolants
- d. Select appropriate tooling for application

Module Outline:

- I. Discuss Physics of Metal Cutting
  - A. Explain the metal cutting process
  - B. Define metal cutting terms
    - 1. Built-up edge
    - 2. Chip-tool interface
    - 3. Crystal elongation
    - 4. Deformed zone
    - 5. Plastic deformation
    - 6. Plastic flow
    - 7. Rupture
    - 8. Shear angle (plane)
    - 9. Shear zone
    - 10. Cutting force
    - 11. Feed force
    - 12. Cutting Speed
      - a. Surface feet per minute (SFM)
      - b. Revolutions per minute (RPM)
    - 13. Feed
  - C. Discuss machinability of metals
    - 1. Low-carbon steel
    - 2. High-carbon steel
    - 3. Tool steel
    - 4. Alloys
    - 5. Cast iron
  - D. Discuss chip formation
    - 1. Discontinuous
    - 2. Continuous
    - 3. Continuous with built-up edge
- II. Discuss Cutting Tools
  - A. Geometry

        1. Front, or end, relief (clearance)
        2. Side relief
        3. Side cutting edge angle
        4. Nose radius
        5. Side rake angle
        6. Back rake angle
    B. Materials
        1. High-speed tool steel
        2. Cemented carbide
            a. Brazed-tip
            b. Indexable disposable inserts
            c. Coated
        3. Ceramic
        4. Diamond
    C. ANSI insert identification system
    D. Discuss factors that affect tool life
        1. Type material being cut
        2. Microstructure of the material
        3. Hardness of the material
        4. Surface condition of the material
        5. Cutting tool material
        6. Profile of the cutting tool
        7. Type machining operation being performed
        8. Speed, feed, and depth of cut
        9. Effectiveness of cutting fluid
    E. Discuss grinding single-point tools
III. Discuss Cutting Fluids and Coolants
    A. Function
        1. Coolant
        2. Lubricant
        3. Prolong tool life
        4. Control rust
    B. Types
        1. Cutting oils
        2. Soluble oils
        3. Chemical fluids
    C. Desirable characteristics
        1. Good cooling capacity
        2. Good lubricating qualities
        3. Rust resistance
        4. Stability (long life)
        5. Resistance to rancidity
        6. Nontoxic
        7. Transparent
        8. Relatively low viscosity

        - 9. Nonflammable
    - D. Application
        - 1. Flood method
        - 2. Mist method
        - 3. Coolant-fed tooling
- IV. Discuss the Selection of Appropriate Tooling for an Application
    - A. Tool geometry
    - B. Tool material
    - C. Cutting fluids

TLD-F2-HO
Operate Metal Saws
Attachment 1: **MASTER** Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Define bandsaw, horizontal and vertical;
b. Discuss bandsaw safety;
c. Explain machine components and accessories of bandsaws;
d. Discuss application of the various tooth forms, pitch sets, and gages of bandsaw blades;
e. Weld and maintain bandsaw blade;
f. Calculate proper length of bandsaw blade;
g. Use recommended cutting speed and feed rate for specific materials and tooling;
h. Define circular type metal saws, abrasive cutoff and cold circular;
i. Discuss circular saw safety;
j. Explain tooling (blades and wheels) on circular saws; and,
k. Setup and operate bandsaw and circular saw.

Module Outline:

I. Define Bandsaw and Identify Types
  A. Horizontal
  B. Vertical
II. Discuss Bandsaw Safety
III. Explain Machine Components and Accessories of Bandsaws
  A. Horizontal
    1. Saw frame
    2. Vise
    3. Stop gage
    4. Pulleys
    5. Blade tension handle
    6. Roller guide brackets
    7. Saw blade
    8. Power stock feed
    9. Coolant
  B. Vertical (contour)
    1. Column
    2. Head
    3. Base
    4. Pulleys
    5. Table

   6. Saw guides
   7. Table tilt handwheel
   8. Butt welder
   9. Blade grinder
   10. Coolant
   11. Power feed

IV. Discuss Bandsaw Blades
  A. Tooth forms
   1. Precision or regular tooth
   2. Claw or hook tooth
   3. Buttress or skip tooth
  B. Pitch
  C. Set
   1. Raker
   2. Wave
   3. Straight
  D. Width
  E. Gage
  F. Material
  G. Specialty blades

V. Explain How to Calculate Proper Length of Bandsaw Blade

VI. Explain How to Weld and Maintain Bandsaw Blade

VII. Explain How to Determine Cutting Speed and Feed Rate for Specific Materials and Tooling Using Charts And/or Selector Dial

VIII. Define Circular Type Metal Saws and Identify Types and Uses
  A. Cold circular
  B. Abrasive cutoff

IX. Discuss Circular Metal Saw Safety

X. Discuss Tooling (Blades and Wheels) on Circular Saws
  A. Cold circular blades (reiterate tooth forms, pitch, set, gage, and material)
  B. Abrasive cut-off wheels
   1. Grade
   2. Material

XI. Setup and Operate Bandsaw and Circular Saw
  A. Safety
  B. Horizontal
  C. Vertical
  D. Cold circular
  E. Abrasive cutoff

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and,
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

TLD-F3-HO
Operate Drill Presses and Tooling
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

- a. Identify types of drilling machines;
- b. Discuss drilling machine safety;
- c. Explain machine components and accessories of drilling machines;
- d. Describe and give function of various types of tooling used on drilling machines;
- e. Explain processes performed on drilling machines;
- f. Calculate speeds and feeds based on materials and tooling; and,
- g. Set-up and operate drilling machines.

Module Outline:

- I. Identify Types of Drilling Machines
    - A. Bench-type sensitive drill press
    - B. Upright drilling machine
    - C. Radial drilling machine
    - D. Numerical controlled drilling machine
- II. Discuss Drill Safety
- III. Explain Machine Components and Accessories of Drilling Machines
    - A. Major components
        - 1. Base
        - 2. Column
        - 3. Table
        - 4. Drilling head
        - 5. Radial Arm
    - B. Accessories
        - 1. Tool-holding devices
            - a. Chucks
            - b. Sleeves and sockets
        - 2. Work-holding devices
            - a. Vise (drill, angle, contour)
            - b. V-blocks
            - c. Clamps, straps, and step blocks
            - d. Angle plate
            - e. Drill jig
- IV. Describe and Give Function and Maintenance of Various Types of Tooling Used on Drilling Machines
    - A. Drills

    - 1. Twist
      - a. Geometry and parts
      - b. Sizes
      - c. Grinding
    - 2. Center
    - 3. Core
    - 4. Spade
    - 5. Step
  - B. Reamers
    - 1. Rose-type
    - 2. Shell-type
    - 3. Expansion-type
    - 4. Adjustable-type
  - C. Counterbore
  - D. Countersink
  - E. Tap
- V. Explain Processes Performed on Drilling Machines
  - A. Layout for drilling operations
  - B. Drilling
  - C. Reaming
  - D. Counterboring
  - E. Spotfacing
  - F. Countersinking
  - G. Tapping
- VI. Calculate Speeds and Feeds Based on Materials and Tooling
  - A. Drilling
  - B. Reaming
  - C. Counterboring/spotfacing
  - D. Countersinking
  - E. Tapping
- VII. Set-Up and Operate Drilling Machines

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and,
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

TLD-F4-HO
Operate Engine and Turret Lathes and Tooling
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

- a. Define lathes, engine and turret;
- b. Discuss lathe safety;
- c. Explain machine components and accessories of lathes;
- d. Describe and give function and maintenance of various types of tooling used on lathes;
- e. Explain turning processes, inside and outside;
- f. Calculate speeds and feeds based on materials, tooling and setup; and,
- g. Set-up and operate engine and turret lathes.

Module Outline:

- I. Define Lathes and Identify Types
  - A. Engine
  - B. Turret
  - C. Computer Numerical Control (CNC)
- II. Discuss Lathe Safety
- III. Explain Machine Components and Accessories of Lathes
  - A. Major components
    - 1. Bed
    - 2. Headstock
    - 3. Gearbox
    - 4. Carriage
      - a. Saddle
      - b. Cross-slide
      - c. Compound rest
    - 5. Tailstock
  - B. Accessories
    - 1. Centers
    - 2. Chucks
      - a. Three-jaw universal
      - b. Four-jaw independent
      - c. Collet-type
      - d. Magnetic
    - 3. Faceplate
    - 4. Steadyrest
    - 5. Follower rest
    - 6. Lathe dogs

        7. Toolposts
        8. Tool holders
- IV. Describe and Give Function and Maintenance of Various Types of Tooling Used on Lathes
    - A. Types
        - 1. O.D. turning tools
        - 2. I.D. turning tools
        - 3. Face turning tools
        - 4. Threading tools
        - 5. Grooving tools
        - 6. Knurling tools
        - 7. Form tools
    - B. Maintenance and grinding
- V. Explain Turning Processes
    - A. Inside operations
        - 1. Drilling, tapping, reaming
        - 2. Boring
        - 3. Threading
        - 4. Chamfering
        - 5. Grooving
        - 6. Taper boring
    - B. Outside operations
        - 1. Turning
            - a. Chuck turning
            - b. Between centers
            - c. Form turning
            - d. Taper turning
        - 2. Facing
        - 3. Threading
        - 4. Grooving
        - 5. Knurling
        - 6. Chamfering
        - 7. Cut-off
    - C. Explain depth of cut
- VI. Calculate Speeds and Feeds Based on Materials, Tooling, and Setup
- VII. Set-Up and Operate Engine and Turret Lathes

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and,
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

TLD-F5-HO
Operate Vertical and Horizontal Mills and Tooling
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

- a. Define milling machines, horizontal and vertical;
- b. Discuss mill safety;
- c. Explain machine components and accessories of milling machines;
- d. Describe and give function of different types of tooling used on milling machines;
- e. Explain milling processes;
- f. Explain boring processes on milling machine;
- g. Explain precision set-ups on the milling machine;
- h. Calculate speeds, feeds, and depth of cut based on materials, tooling and setup; and,
- i. Set-up and operate horizontal and vertical milling machine for milling and boring operations.

Module Outline:

- I. Define Milling Machines
  - A. Horizontal
    - 1. Manufacturing type
    - 2. Knee-and-column type
  - B. Vertical
    - 1. Standard
    - 2. Ram type
  - C. CNC Machining Centers
- II. Discuss Mill Safety
- III. Explain Machine Components and Accessories of Milling Machines
  - A. Major components
    - 1. Base
    - 2. Column
    - 3. Overarm
    - 4. Table
    - 5. Saddle
    - 6. Knee
  - B. Accessories
    - 1. Fixtures
    - 2. Vises
    - 3. Parallel bars
    - 4. Arbors, collets, and adapters

5. Milling attachment
6. Slotting attachment
7. Indexing or dividing head
8. Rotary table
9. Backlash eliminator

IV. Describe and Give Function of Different Types of Tooling Used on Milling Machines
A. Arbor type cutters
1. Plain
2. Side-milling
3. Face-milling
4. Angular
5. Formed

B. End mills
1. Standard
2. Ball
3. Bull
4. Formed
5. Shell

C. Specialty cutters
1. T-slot
2. Dovetail
3. Woodruff keyseat
4. Flycutter

D. Tooling materials
1. High speed steel
2. Carbide brazed
3. Carbide inserted

V. Explain Milling Processes
A. Face milling
B. Side milling
C. Straddle milling
D. Slot or keyseat milling
E. Gang milling
F. Sawing or slitting
G. Specialty milling (T-slot, dovetail, woodruff keyseat, etc.)

VI. Explain Boring Processes on Milling Machine

VII. Explain Precision Set-Ups on the Milling Machine
A. Using the dial indicator
B. Digital readout devices
C. Aligning the head and table
D. Aligning the vise or fixture
E. Finding edge, center, or face locations

VIII. Calculate Speeds, Feeds, and Depth of Cut Based on Materials, Tooling and Setup

IX. Set-Up and Operate Horizontal and Vertical Milling Machine for Milling and Boring Operations

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and,
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

TLD-F6-HO
Operate Precision Grinders
Attachment 1: **MASTER** Handout

Objective(s):

Upon completion of this module the student will be able to:

- a. Define types of precision grinders;
- b. Discuss grinding safety;
- c. Identify major components and accessories of grinding machines;
- d. Identify types, nomenclature, and uses of grinding wheels;
- e. Discuss care and maintenance of grinding wheels;
- f. Identify the factors involved in electing grinding wheel specifications;
- g. Explain grinding processes; and,
- h. Setup and operate precision grinding machines.

Module Outline:

- I. Define Types and Uses of Precision Grinders
  - A. Surface
    - 1. Horizontal with reciprocating or rotary motion table
    - 2. Vertical with reciprocating or rotary motion table
  - B. Cylindrical
    - 1. Center type (universal)
    - 2. Centerless
  - C. Universal tool and cutter
- II. Discuss Grinding Safety
- III. Identify Major Components and Accessories of Grinding Machines
  - A. Hydraulic surface grinder
    - 1. Major Components
      - a. Base
      - b. Saddle
      - c. Table
      - d. Column
    - 2. Accessories
      - a. Magnetic chuck
      - b. Chuck blocks
      - c. Sine chuck
      - d. Adapter plate
      - e. Angle plate
      - f. Diamond dresser
  - B. Cylindrical grinder
    - 1. Major Components
      - a. Base

      - b. Wheelhead
      - c. Table
      - d. Headstock
      - e. Footstock
      - f. Work rest blade (centerless)
      - g. Regulating wheel (centerless)
    - 2. Accessories
      - a. Backrest or steadyrest
      - b. Center rest
      - c. Internal grinding attachment
  - C. Tool and cutter grinder
    - 1. Major components
      - a. Base
      - b. Wheelhead
      - c. Saddle
      - d. Table
    - 2. Accessories and attachments
      - a. Headstock
      - b. Footstock
      - c. Centering gage
      - d. Tooth rest
      - e. Tooth rest blade
      - f. Mandrel
- IV. Identify Types, Nomenclature, and Uses of Grinding Wheels
  - A. Abrasive Types
    - 1. Aluminum Oxide
    - 2. Silicon Carbide
  - B. Grain Size
  - C. Grade
  - D. Structure
  - E. Bond Type
  - F. Shapes
- V. Discuss the Procedures to Care and Maintain Grinding Wheels
  - A. Inspecting
  - B. Mounting
  - C. Balancing
  - D. Truing and dressing
- VI. Identify the Factors Involved in Selecting Grinding Wheel Specifications
  - A. Type of grinding operation
  - B. Material to be ground
  - C. Amount of stock to be removed
  - D. Area of contact
  - E. Finish required
  - F. Wheel speed
  - G. Method of cooling

VII. Explain Grinding Processes
  A. Surface grinding operations
    1. Squaring blocks (flat and edge grinding)
    2. Vertical surfaces
    3. Angular surfaces
    4. Form grinding
    5. Cutoff operations
  B. Cylindrical grinding operations
    1. Outside diameters
    2. Tapers
    3. Internal diameters
    4. Centerless grinding
  C. Tool and cutter grinder operations
    1. Cylindrical grinding
    2. Plain helical milling cutter
    3. End mill
    4. Side and face milling cutters
    5. Form-relieved cutter

VIII. Setup and Operate Grinding Machines (Surface, Cylindrical, and Tool and Cutter)

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

TLD-F7-HO
Operate Heat Treating Equipment and Processes
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this module the student will be able to:

- a. Define heat treatment;
- b. Identify types of heat treating equipment;
- c. Identify the three major steps for all heat-treatment processes;
- d. Explain heat treating processes and procedures;
- e. Explain the terms relevant to heat treatment processes; and,
- f. Set-up and operate heat treating equipment.

Module Outline:

- I. Define Heat Treatment
- II. Identify Types of Heat Treating Equipment
- III. Identify the Three Major Steps for All Heat-treatment Processes
    - A. Heating
    - B. Soaking
    - C. Cooling
- IV. Explain Heat Treating Processes and Procedures
    - A. Hardening
        - 1. Hardening temperature
        - 2. Quenching and quenching solutions
        - 3. Factors affecting hardness
    - B. Tempering, or drawing
        - 1. Need for tempering
        - 2. Tempering temperatures (and factors)
        - 3. Procedure
    - C. Annealing
        - 1. Need for annealing
        - 2. Types of annealing (and procedures)
            - a. Full annealing
            - b. Process annealing
            - c. Spheroidizing annealing
    - D. Normalizing
        - 1. Normalizing temperature
        - 2. Procedure
    - E. Other methods of heat treatment
        - 1. Case-hardening
            - a. Methods
            - b. Hardening

        2. Flame Hardening
        3. Induction Hardening
        4. Laser and electron beam hardening

V. Explain the Terms Relevant to Heat Treatment Processes
    A. Pearlite
    B. Cementite
    C. Austenite
    D. Martensite
    E. Troosite, sorbite, or tempered martensite
    F. Eutectoid Steel
    G. Hypereutectoid steel
    H. Hypoeutectoid steel
    I. Decalescence point
    J. Recalescence point
    K. Lower critical temperature point
    L. Upper critical temperature point
    M. Critical range
    N. Body-centered cube
    O. Face-centered cube

VI. Set-Up and Operate Heat Treating Equipment

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and,
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

TLD-F8-HO
Operate Sheet Metal Equipment
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this module the student will be able to:

a. Discuss fabrication of sheet metal parts;
b. Discuss gas/plasma cutting equipment and processes;
c. Discuss shearing operation and equipment;
d. Discuss pressworking processes;
e. Demonstrate sheet metal layout; and,
f. Apply conservation-of-material concepts.

Module Outline:

I. Discuss Fabrication of Sheet Metal Parts
  A. Sheet metal definition
  B. Sheet metal sizes
  C. Pattern development
  D. Hems, edges, and seams
II. Discuss Gas Cutting Equipment
  A. Oxygen-acetylene gas torch
  B. Plasma torch (nitrogen and oxygen)
  C. Single and gantry types
  D. Control methods
    1. Tracer and "Electric Eye"
    2. CNC
III. Discuss Shearing Operations and Equipment
IV. Discuss Pressworking Processes
  A. Punch press
  B. CNC turret punch press
  C. Press brake
  D. Roll forming machine
V. Discuss Sheet Metal Layout
  A. Templates
  B. Layout-on-metal
VI. Discuss Conservation-of-Material Concepts

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and,
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

TLD-F9-HO
Operate Welding Equipment and Processes
Attachment 1: MASTER Handout

Objectives:

Upon completion of this module the student will be able to:
- a. Discuss welding safety;
- b. Identify and discuss types of welds;
- c. Identify and discuss weld joints;
- d. Identify and interpret weld symbols;
- e. Identify and discuss welding processes;
- f. Discuss weld characteristics; and,
- g. Discuss edge preparation and fit-up.

Module Outline:

- I. Discuss Welding Safety
- II. Identify and Discuss Types of Welds
  - A. Surfacing weld
  - B. Fillet weld
  - C. Groove weld
  - D. Plug and slot weld
- III. Identify and Discuss Weld Joints
  - A. Butt joint
  - B. Tee joint
  - C. Lap joint
  - D. Corner joint
  - E. Edge joint
- IV. Identify and Interpret Weld Symbols
- V. Identify and Discuss Welding Processes
  - A. Oxyacetylene welding (OAW)
  - B. Arc Welding
    - 1. Shielded Metal-Arc Welding (SMAW)
    - 2. Gas Shielded-Arc Welding (GTAW and GMAW)
  - C. Other Welding Processes
    - 1. Brazing
    - 2. Surfacing
    - 3. Pipe Welding
    - 4. Cutting Operations
    - 5. Resistance
- VI. Discuss Weld Characteristics
  - A. Penetration
  - B. Defects

C. **Residual Stresses**
D. **Distortion**

VII. **Discuss Edge Preparation and Fit-up**

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    - a. No loose clothing, including ties;
    - b. Long hair properly stowed;
    - c. No jewelry;
    - d. Hard, closed-toe shoes;
    - e. Eye protection (safety glasses); and,
    - f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

TLD-F10-HO
Estimate Time Required/Cost to Produce a Part
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this module the student will be able to:

- a. Determine component parts and requirements for assembly;
- b. Determine processes required to produce piece parts;
- c. Determine the material requirements and costs;
- d. Determine tooling required;
- e. Estimate time required to manufacture and assemble parts; and,
- f. Estimate manufacturing costs.

Module Outline:

- I. Determine Component Parts and Requirements for Assembly
- II. Determine Processes Required to Produce Piece Parts
  - A. Considerations
    - 1. Shape and size
    - 2. Fit and form tolerances and specifications
    - 3. Safety factors
  - B. Order of operations
  - C. Buy vs. make
    - 1. Capabilities
    - 2. Workload
- III. Determine the Material Requirements and Costs
  - A. Stock material
    - 1. Types and sizes
    - 2. Quantity required
      - a. Finished quantity
      - b. Machining excess
      - c. Scrap factor
      - d. Material conservation techniques
    - 3. Calculating material costs
      - a. Cost per unit
      - b. Total amount required
      - c. Freight costs
      - d. Overhead
  - B. Purchased components
- IV. Determine Tooling Required
  - A. Fixtures, jigs, vices, etc.
  - B. Cutting tools
  - C. Lubrication/coolant requirements

- D. Additional resources required
- V. Estimate Manufacturing Time
  - A. Setup
    - 1. Lot size
    - 2. Tooling
    - 3. Rigidity
  - B. Cycle time
    - 1. Speeds and feeds
    - 2. Depth of cut
  - C. Tool life
  - D. Handling time
    - 1. Transport
    - 2. Load/unload
  - E. Personal allowance time
- VI. Estimate Manufacturing Costs (MLO)
  - A. Material
  - B. Labor
  - C. Overhead

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and,
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

TOOL AND DIE MAKER .... skilled workers who produce tools, dies, and special guiding and holding devices that are used in machining.

	Duties	Tasks												
A	Practice Safety	A-1 Follow safety manuals and all safety regulations/ requirements	A-2 Maintain safe equipment and machinery	A-3 Use safe operating procedures for hand and machine tools	A-4 Maintain a clean and safe work environment	A-5 Use safe material handling practices	A-6 Consult and apply MSDS for hazards of various materials							
B	Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Perform basic algebraic operations	B-3 Use basic geometric principles	B-4 Perform basic trigonometric functions	B-5 Use and apply Cartesian Coordinate System								
C	Interpret Engineering Drawings and Related Documents	C-1 Interpret and understand basic layout/types of drawings	C-2 Interpret, review, and apply blueprint notes, dimensions, and tolerances	C-3 Use and apply Geometric Dimensioning and Tolerancing (GD&T)	C-4 Demonstrate traditional mechanical drafting and sketching techniques	C-5 Understand and use quality systems								
D	Demonstrate Knowledge of Manufacturing Materials	D-1 Identify materials with desired properties	D-2 Identify materials and processes to produce a part	D-3 Discuss classification systems for metal										
E	Measure/ Inspect	E-1 Understand metrology terms	E-2 Select measurement tools	E-3 Measure with hand held instruments	E-4 Eliminate measurement variables	E-5 Measure/inspect using surface plate and accessories	E-6 Inspect using stationary equipment							
F	Demonstrate Knowledge of Manufacturing Processes	F-1 Discuss metal cutting and metal cutting tools	F-2 Operate metal saws	F-3 Operate drill presses and tooling	F-4 Operate engine and turret lathes and tooling	F-5 Operate vertical and horizontal mills and tooling	F-6 Operate precision grinders	F-7 Operate heat treating equipment and processes	F-8 Operate sheet metal equipment	F-9 Operate welding equipment and processes	F-10 Estimate time required/ cost to produce a part			
G	Use Computers	G-1 Use computer operating systems	G-2 Understand computer terminology	G-3 Use file management systems	G-4 Install and use software packages									
H	Perform CAD/ CAM and CNC Programming Tasks	H-1 Discuss fundamentals of CNC machines and controls	H-2 Program and operate CNC milling machine and machining center	H-3 Program and operate CNC lathe	H-4 Use Computer-Aided Drafting (CAD) system	H-5 Create 3-D solid models	H-6 Use Computer-Aided Manufacturing (CAM) system							
I	Perform Tool and Die Making Operations	I-1 Discuss basic types and functions of jigs and fixtures	I-2 Utilize concepts of jig and fixture design	I-3 Demonstrate understanding of different types of industrial dies	I-4 Utilize basic die theory	I-5 Utilize principles of die design	I-6 Perform tool and die repair	I-7 Demonstrate tool and die making skills						
J	Operate Electrical Discharge Machine (EDM)	J-1 Discuss fundamentals of EDM	J-2 Setup and operate conventional sinker EDM	J-3 Program, setup, and operate CNC sinker EDM and EDM drill	J-4 Program, setup, and operate CNC wire EDM									

DutyG

TLD-G1-HO
Use Computer Operating Systems
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this module the student will be able to:

- a. Distinguish between a directory/file folder and a file;
- b. Understand data organization and terminology;
- c. Explain the function of an operating system;
- d. Explain what the term "IBM compatible" means;
- e. Use a mouse;
- f. Utilize file manager in Windows 3.1 to view directories and files;
- g. Utilize explorer in Windows 95 to view folders and files; and,
- h. Explain and use basic network concepts.

Module Outline:

- I. Introduction to Computers
  - A. Discuss hardware components
  - B. Explain disk drive configurations
  - C. Discuss software
    - 1. Application programs
    - 2. Operating systems
      - a. DOS
      - b. Windows
      - c. Windows 95
      - d. Network operating systems
  - D. Discuss brands of computers
    - 1. Apple & MacIntosh
    - 2. IBM & compatibles
  - E. Explain data organization
    - 1. Files
    - 2. Filenames and extensions
    - 3. Root directory & backward slash (\)
    - 4. Directory and subdirectory structure
  - F. Explain the terms directory path and file specification
- II. Introduction to the Windows Operating System
  - A. Discuss how to start Windows
  - B. Discuss basic mouse operations
    - 1. Pointing
    - 2. Clicking
    - 3. Double clicking
    - 4. Dragging

- C. Discuss Windows elements
  1. Window borders
  2. Title bar
  3. Control-menu box
  4. Mouse pointer
  5. Sizing buttons
  6. Scroll bar and arrows
  7. Menu bar
  8. Pull-down menus
  9. Work area
  10. Icons
- D. Use File Manager
  1. Explain the file manager screen
  2. Change drives
  3. Expand directories
  4. Collapse directories
  5. Change file information displayed
  6. Run an application
- E. Run an application from an icon in Program Manager

III. Introduction to Windows 95 Operating System

- A. Discuss Windows 95 desktop components
  1. My Computer icon
  2. Recycle Bin icon
  3. Network Neighborhood icon
  4. Start button
  5. Taskbar
- B. Use Windows 95
  1. Open a window from an icon
  2. Use sizing buttons and close button
  3. Discuss Start menu
  4. Open an application using the Start button
  5. Explain shut down menu under Start
  6. Use Windows Explorer
     - a. Explain Windows Explorer toolbar buttons
     - b. Explain folders and subfolders
     - c. Select folders
     - d. Open and close folders
     - e. Change drives
     - f. Change file list display

IV. Introduction to Computer Network Systems

- A. Explain what a network is
- B. Discuss basic network components
  1. File server
  2. Network operating system (NOS)
  3. Local area network (LAN) cable

  4. Network devices

C. Explain types of networks
  1. Campus
  2. National
  3. International

D. Explain and use basic network concepts
  1. File server login/logout
  2. Application sharing
  3. Document sharing
  4. Electronic mail

TLD-G1-LW1
Use Computer Operating Systems
Attachment 2: **MASTER** Laboratory Worksheet No. 1

Introduction to Using Windows 3.1

1. Double-click the Main Group and open the File Manager. Click Tree and choose Indicate Expandable Branches, if it has not been selected. What lets you know this selection has been made? What does this selection do?

   ____

2. Select the root of drive C. Choose Tree from the command bar. Then clock Collapse Branch. What does this selection do?

   ____

3. Choose Tree again and click Expand One Level. How many directories/folders are on drive C?

   ____

4. In the command bar, select Tree and choose Expand All. What happened?

   ____

5. Find the folder WPWIN. How many subdirectories/subfolders are listed under the directory/folder name TEMPLATE?

   ____

6. Double-click a directory/folder that contains a subdirectory/subfolder. What happened?

   ____

7. What happens if you double-click the folder again?

   ____

8. Place a disk in drive A. How can you view the contents of the file in drive A?

   ____

9. Select drive C again. Under View, choose All File Details. What happened?

   ____

10. Select the MACROS subdirectory/subfolder under WPWIN. Go to View and choose Sort by Name. What is the first file listed?______________________

    Sort by Type. The first file listed is ______________________________

Sort by Size. The first file listed is ______________________________

Sort by Date. The first file listed is ______________________________

11. How can the list of files in a particular folder be viewed?

____

12. Exit File Manager and close the Main Group. How did you do this?

____

13. How could an application package, such as WordPerfect for Windows, be loaded and run from Windows 3.1?

____

Introduction to Using Windows 95

1. Click Start, go to Programs, and click Windows Explorer.

2. Maximize the window, if necessary.

3. Click in the square to the left of the My Computer icon.

4. What does a + in the square mean? What happens when you click the +?

   ____

5. What does a - in the square mean? What happens when you click the -?

   ____

6. Click on C:. How many directories/folders are at the root of drive C? How many files are at the root of drive C?

   ____

7. Expand drive C. How may directories under drive C are expandable?

   ____

8. How do you expand and collapse directories/folders?

   ____

9. Click View and select Details, what happened?

   ____

10. Put a disk in drive A and select drive A. How many directories/folders and files are at the root of drive A?

    ____

11. Select drive C again and open the DOS folder. How can you sort the file list by name, type, size, or date?

    ____

12. Exit Explorer. How did you do this?

    ____

13. How do you run an application package, such as WordPerfect, from Windows 95?

TLD-G1-LW3
Using Computer Operating Systems
Attachment 4: MASTER Laboratory Worksheet No. 3

Introduction to Using Networks

1. Locate the file server? Where is it?

   ____

2. What type of NOS is being used in this lab?

   ____

3. How do you login to the file server? What is the purpose of this?

   ____

4. Can you send an e-mail message in this lab? If so, what steps must be taken to do this?

   ____

5. What type of "sharing" can be done?

   ____

6. How can the directory structure of the file server be viewed?

   ____

7. Logout of the network. What is the purpose of this?

   ____

TLD-G2-HO
Understand Computer Terminology
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Explain what RAM is;
b. Explain what ROM is;
c. Explain memory caching;
d. Define and convert bytes, kilobytes, and megabytes;
e. Discuss the function of a central processing unit;
f. Discuss processor speed; and,
g. Understand RS-232 protocol.

Module Outline:

I. Explain What Memory Is
  A. RAM
  B. ROM
  C. Cache memory
  D. Measuring memory
    1. Byte
    2. Kilobyte
    3. Megabyte
II. Discuss Purpose and Function Of:
  A. Central Processing Units (CPUs)
  B. Processor performance
    1. Speed
    2. Generation
    3. Type
  C. RS-232 serial port
III. Determine the Amount of Available Memory on a System
  A. Choose About from the Help menu in Program Manager for Windows 3.1
  B. Choose About from the Help menu in Windows Explorer for Windows 95

TLD-G3-HO
Use File Management Systems
Attachment 1: MASTER Handout

Objectives:

Upon completion of this unit the student will be able to:

- a. Explain file management concepts;
- b. Create and delete directories/folders;
- c. Copy a file(s) from one directory to another;
- d. Copy a file(s) between a floppy disk and a hard drive;
- e. Rename, move, and delete a file(s); and,
- f. Format disks and make system disks.

Module Outline:

- I. Explain and Discuss File Management Concepts
  - A. Copying a file(s)
  - B. Deleting a file(s)
  - C. Moving a file(s)
  - D. Renaming a file(s)
  - E. Creating a directory
  - F. Deleting a directory
  - G. Copying a disk
  - H. Formatting a disk
  - I. Making a system disk
- II. Use File Manager in Windows 3.1 to Perform File Management Operations
  - A. Use the file menu to:
    - 1. Create a directory
      - a. On the hard drive
      - b. On a floppy disk
    - 2. Copy a file(s)
      - a. From one directory to another
      - b. From a floppy disk to the hard drive
      - c. From the hard drive to a floppy disk
    - 3. Move a file(s)
    - 4. Rename a file(s)
    - 5. Delete a file(s)
    - 6. Delete a directory
  - B. Use the disk menu to:
    - 1. Copy a disk
    - 2. Format a disk
    - 3. Make a system disk
- III. Use Windows 95 to Perform File Management Operations

A. Use the file menu in Windows Explorer to:
    1. Create a new folder on the hard drive
    2. Create a new folder on the floppy drive

B. Use the edit menu in Windows Explorer to:
    1. Copy a file(s) from one directory to another
    2. Copy a file(s) from a floppy disk to the hard drive
    3. Copy a file(s) from the hard drive to a floppy disk
    3. Cut a file(s)
    4. Paste a file(s)

C. Use the file menu in Windows Explorer to:
    1. Rename a file(s)
    2. Delete a file(s)
    3. Delete a folder

D. Use My Computer on the Windows 95 desktop to:
    1. Format a disk
    2. Make a system disk

Using Windows 3.1 to Perform File Management Operations

*** A DATA DISK WILL BE NEEDED TO COMPLETE THESE EXERCISES. ***

1. Open the Main window and start File Manager.
2. Maximize the directory tree window.
3. View the contents of drive A and create a directory called RAINBOW.
4. View the contents of the hard drive by selecting the root icon for drive C.
5. Expand the directory named WINDOWS and view the files in the SYSTEM subdirectory.
6. Sort the files in SYSTEM by size and select the four smallest files.
7. Copy these files to the RAINBOW directory on drive A.
8. Check to see that these four files are still in the SYSTEM subdirectory. Now, view the contents of the RAINBOW directory on drive A to make sure the files were copied.
9. Rename each of the files under RAINBOW on drive A as Red, Blue, Green, and Yellow.
10. Create another directory on drive A named COLORS.
11. Move the files Red and Green from RAINBOW to COLORS.
12. Check to see that RAINBOW now contains only the files named Blue and Yellow.
13. Check to see that COLORS contains two files named Red and Green.
14. Delete the Yellow file in the RAINBOW directory.
15. Delete the RAINBOW directory.

16. Create a directory on the hard drive named your first name.

17. Copy the files on the disk in drive A to the directory on the hard drive with your name.

18. Format your data disk and then view its contents.

19. Make a system disk with your data disk. Use this system disk to restart the computer.

TLD-G3-LW2
Use File Management Systems
Attachment 3: **MASTER** Laboratory Worksheet No. 2

Using Windows 95 to Perform File Management Operations

*** A DATA DISK WILL BE NEEDED TO COMPLETE THESE EXERCISES. ***

1. Click START and choose Windows Explorer under Programs.
2. Maximize this window.
3. View the contents of your data disk in drive A and create a folder named SAMPLE on your data disk.
4. View the contents of the hard drive by selecting the root icon for drive C.
5. Expand the WINDOWS folder and view the files in the HELP subdirectory.
6. View the details of the files and arrange the files by size.
7. Select the four smallest files and copy them to the SAMPLE folder on drive A.
8. Check to see that these four files are still in the HELP folder on the hard drive. Now, view the contents of the SAMPLE folder on drive A to make sure the files were copied.
9. Rename each of the files under SAMPLE on drive A as File1, File2, File3, and File4.
10. Create another folder on drive A named EXERCISE.
11. Move the files File1 and File3 under SAMPLE to the folder named EXERCISE.
12. Check to see that SAMPLE now contains the files named File2 and File4.
13. Check to see that EXERCISE contains File1 and File3.
14. Delete File2 in SAMPLE.
15. Delete the folder SAMPLE.

16. Create a folder on the hard drive named PRACTICE.

17. Copy the files on the disk in drive A to the PRACTICE folder on the hard drive.

18. Format your data disk. Does it still contain your files?

19. Make your data disk a system disk. Explain the value of having a system disk.

TLD-G4-HO
Install and Use Software Packages
Attachment 1: MASTER Handout

Objectives:

Upon completion of this unit the student will be able to:

a. Install a software package to a hard disk;
b. Configure the system parameters upon installation;
c. Create a word processing document;
d. Create a spreadsheet; and,
e. Open, edit, enhance, save, and print word processing and spreadsheet files.

Module Outline:

I. Explain How to Install Software Packages Using Windows 3.1
   A. Install from a CD-ROM
   B. Install from diskettes
II. Explain How to Install Software Packages Using Windows 95
   A. Install from a CD-ROM
   B. Install from diskettes
III. Explain How to Configure System Parameters for a Software Package
   A. Modification to AUTOEXEC.BAT and CONFIG.SYS
   B. Modification of INI files (e.g. WIN.INI, SYSTEM.INI)
   C. Plotter/printer driver configurations
   D. Digitizer pad/mouse driver configurations
IV. Use a Word Processor Software Package (e.g. WordPerfect, MS Word)
   A. Typing a document
   B. Using cursor movement keys
   C. Editing a document with backspace and delete
   D. Using the spelling checker
   E. Saving a file
   F. Printing a file
   G. Closing a file
   H. Opening a file
   I. Changing the margins
   J. Using bold, italics, and underline
   K. Changing alignment
V. Use a Spreadsheet Software Package (e.g. Lotus 123, MS Excel)
   A. Entering values and labels
   B. Editing the spreadsheet
   C. Using formulas and functions
   D. Changing column widths

E. **Changing number format**
F. **Changing alignment**
G. **Copying formulas and functions**
H. **Printing the spreadsheet**
I. **Saving the spreadsheet and chart**

TLD-G4-LW1
Install and Use Software Packages
Attachment 2: **MASTER** Laboratory Worksheet No. 1

Creating a Word Processing Document

I. Creating Documents

A. Key the following document in a word processing software package.

The Vernier Caliper
The basic parts of a vernier caliper are a main scale which is similar to a steel rule with a fixed jaw and a sliding jaw with a vernier scale. They are available in a wide range of lengths with different types of jaws and scale graduations.

B. Check your spelling.

C. Save the document on your data disk as CALIPERS and print.

D. Close the document.

E. Create another new document and enter the text below.

Micrometers
Micrometers are basic measuring instruments used by technicians in the processing and checking of parts. They are available in a wide range of sizes and types.

Outside micrometers are used to measure dimensions between parallel surfaces of parts and outside diameters of cylinders. Other types, such as depth micrometers, screw thread micrometers, disc and blade micrometers, and inside micrometers, also have wide application in the machine shop.

F. Boldface and italicize the title.

G. Change the top margin to 2.8 inches and check the spelling.

H. Save the document on your data disk under the name MICS and print.

I. Close the document.

II. Opening Documents and Editing

A. Open the document CALIPERS.

B. Insert Decimal-Inch in the title between "The" and "Vernier", so the title will read The Decimal-Inch Vernier Caliper. Also, boldface the title.

C. Insert the following text as the second sentence.

The vernier scale slides parallel to the main scale and provides a degree of precision to 0.001".

D. In the last sentence, change "They" to "Calipers".

E. Change the top margin to 2.7 inches and check your spelling.

F. Save under the same name and print.

G. Open the document MICS.

H. Make the two paragraphs one.

I. Save the document under the same name and print.

TLD-G4-LW2
Install and Use Software Packages
Attachment 3: **MASTER** Laboratory Worksheet No. 2

Creating a Spreadsheet

I. Create a Spreadsheet, Change Column Widths, and Alignment

A. Enter the following labels as shown below to create a spreadsheet. Change the column width as necessary.

Diametral Pitch	Number of Teeth	Pitch Diameter (inches)	Addendum (inches)	Dedendum (inches)

B. Center the labels in the cells.

C. In the Diametral Pitch column enter the following values: 4, 6, 8, and 3.

D. In the Number of Teeth column enter the following values: 45, 75, 44, and 54.

E. Save the spreadsheet to your data disk as BEVEL and print.

F. Open a new document and enter the following information below. Change the column widths as necessary.

Name	Rate	Hours	Gross Pay
Natalie Nicholson	6.80	40	
Dave Miller	8.60	40	
Karen Lark	8.60	38	
Taylor Smithsonian	5.50	20	

G. Center the values in the Hours column.

H. Set the number format in the Rate column to show two decimal places and the number format in the Hours column to show zero decimal places.

I. Save the spreadsheet to your data disk as PAYROLL and print.

II. Create and Copy Formulas/functions and Edit the Spreadsheet

A. Place BEVEL back on your desktop.

B. Enter the following formulas in the appropriate cell and copy to other cells where the formula is needed.

Pitch Diameter = Number of Teeth / Diametral Pitch
Dedendum = 1.157 / Diametral Pitch
Addendum = 1/ Diametral Pitch

C. Save under the same name and print.

D. Change the Diametral Pitch in the first cell from 4 to 5.

E. Change the Number of Teeth in the last cell from 54 to 50

F. Add a Diametral Pitch of 10 with the Number of Teeth given as 80.

G. Copy the formulas to the new row.

H. Save and print.

I. Place PAYROLL back on the desktop and enter the formula to compute the Gross Pay. (Gross Pay = Rate * Hours)

J. Format the Gross Pay as currency.

K. Add the Hours column.

L. Change Dave Miller's rate of pay to $9.00.

M. Save and print.

TOOL AND DIE MAKER .... skilled workers who produce tools, dies, and special guiding and holding devices that are used in machining.

	Duties	Tasks												
A	Practice Safety	A-1 Follow safety manuals and all safety regulations/requirements	A-2 Maintain safe equipment and machinery	A-3 Use safe operating procedures for hand and machine tools	A-4 Maintain a clean and safe work environment	A-5 Use safe material handling practices	A-6 Consult and apply MSDS for hazards of various materials							
B	Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Perform basic algebraic operations	B-3 Use basic geometric principles	B-4 Perform basic trigonometric functions	B-5 Use and apply Cartesian Coordinate System								
C	Interpret Engineering Drawings and Related Documents	C-1 Interpret and understand basic layout/types of drawings	C-2 Interpret, review, and apply blueprint notes, dimensions, and tolerances	C-3 Use and apply Geometric Dimensioning and Toleranceing (GD&T)	C-4 Demonstrate traditional mechanical drafting and sketching techniques	C-5 Understand and use quality systems								
D	Demonstrate Knowledge of Manufacturing Materials	D-1 Identify materials with desired properties	D-2 Identify materials and processes to produce a part	D-3 Discuss classification systems for metal										
E	Measure/Inspect	E-1 Understand metrology terms	E-2 Select measurement tools	E-3 Measure with hand held instruments	E-4 Eliminate measurement variables	E-5 Measure/inspect using surface plate and accessories	E-6 Inspect using stationary equipment							
F	Demonstrate Knowledge of Manufacturing Processes	F-1 Discuss metal cutting and metal cutting tools	F-2 Operate metal saws	F-3 Operate drill presses and tooling	F-4 Operate engine and turret lathes and tooling	F-5 Operate vertical and horizontal mills and tooling	F-6 Operate precision grinders	F-7 Operate heat treating equipment and processes	F-8 Operate sheet metal equipment	F-9 Operate welding equipment and processes	F-10 Estimate time required/cost to produce a part			
G	Use Computers	G-1 Use computer operating systems	G-2 Understand computer terminology	G-3 Use file management systems	G-4 Install and use software packages									
H	Perform CAD/CAM and CNC Programming Tasks	H-1 Discuss fundamentals of CNC machines and controls	H-2 Program and operate CNC milling machine and machining center	H-3 Program and operate CNC lathe	H-4 Use Computer-Aided Drafting (CAD) system	H-5 Create 3-D solid models	H-6 Use Computer-Aided Manufacturing (CAM) system							
I	Perform Tool and Die Making Operations	I-1 Discuss basic types and functions of jigs and fixtures	I-2 Utilize concepts of jig and fixture design	I-3 Demonstrate understanding of different types of industrial dies	I-4 Utilize basic die theory	I-5 Utilize principles of die design	I-6 Perform tool and die repair	I-7 Demonstrate tool and die making skills						
J	Operate Electrical Discharge Machine (EDM)	J-1 Discuss fundamentals of EDM	J-2 Setup and operate conventional sinker EDM	J-3 Program, setup, and operate CNC sinker EDM and EDM drill	J-4 Program, setup, and operate CNC wire EDM									

Duty H

TLD-H1-HO
Discuss Fundamentals of CNC Machines and Controls
Attachment 1: MASTER Handout

Objectives:

Upon completion of this module the student will be able to:

- a. Identify and describe essentials and safety of CNC systems;
- b. Identify and describe types of CNC hardware and software;
- c. Identify and describe machine axes and coordinate systems; and,
- d. Identify and describe coordinate systems.

Module Outline:

- I. Identify and Describe Essentials and Safety of CNC Systems
  - A. Identify and explain essentials
    - 1. Define numerical control
    - 2. Explain history and future of CNC technology
    - 3. Identify basic elements of CNC system
    - 4. Define Computer Numerical Control (CNC)
    - 5. Explain advantages and limitations of CNC
    - 6. Identify applications of CNC technology
  - B. Compare types of CNC systems
    - 1. Identify and describe modes on numerical control systems
    - 2. Explain difference between the following:
      - a. Point-to-point
      - b. Axial path
      - c. 45° line type
      - d. Linear path
      - e. Continuous path
    - 3. Describe CNC interpolation
    - 4. Identify types of CNC interpolations
    - 5. Explain difference between open loop and closed loop systems
    - 6. List benefits and problems of open and closed loop systems
  - C. Demonstrate safety practices related to CNC systems
    - 1. Demonstrate safety practices, including:
      - a. Safety guard/door interlocks
      - b. Power box interlocks
      - c. Tool loading and unloading
      - d. Loading and unloading work holding devices
      - e. Machine coolant disposal
    - 2. Describe/identify personal safety equipment
- II. Identify and Describe Types of CNC Hardware and Software
  - A. Identify and describe CNC hardware

    - 1. Compare NC and CNC systems
    - 2. Identify components of CNC machine control unit (MCU)
    - 3. Define applications of operator control panel
    - 4. Explain functions of operator control panel
    - 5. Define utilities found on typical control panel
    - 6. Select appropriate CNC controls
  - B. Describe CNC software
    - 1. Describe software related to machine tool
    - 2. Describe applications of operation, interface and application software
    - 3. Describe interface of software and hardware
  - C. Explain feed back drive system
    - 1. Describe feed drive system
    - 2. Explain feed back mechanisms
    - 3. Compare direct and indirect measurement systems
- III. Identify and Describe Machine Axes and Coordinate Systems
  - A. Identify and describe machine axes
    - 1. Define and identify machine axes X, Y and Z
    - 2. Identify and describe linear axes using right hand rule
    - 3. Identify and define primary rotary axes A, B and C
  - B. Describe coordinate systems
    - 1. Describe Cartesian coordinate system as used in NC program
    - 2. Define relationship of Cartesian coordinate system with machine axes
  - C. Define characteristics of positioning systems
    - 1. Define application of absolute positioning systems
    - 2. Define application of incremental positioning systems
  - D. Define reference systems
    - 1. Describe characteristics of:
      - a. Machine reference coordinates
      - b. Work reference coordinates
      - c. Program reference coordinates
      - d. Fixtures offset coordinates
- IV. Describe and Interpret CNC Coding Systems
  - A. Interpret number bases
    - 1. Interpret decimal and binary bases
    - 2. Interpret octal and hexadecimal bases
  - B. Describe NC program storage media
    - 1. Describe the media
    - 2. Describe advantages and disadvantages of each media
  - C. Describe EIA and ASCII formatted tapes
    - 1. Describe EIA format on tapes
    - 2. Describe ASCII format on tapes
    - 3. Describe differences in EIA and ASCII formats

TLD-H2-HO
Program and Operate CNC Milling Machine and Machining Center
Attachment 1: MASTER Handout

Objectives:

Upon completion of this module the student will be able to:
- a. Describe history of vertical machining;
- b. Describe theory of operation;
- c. Describe nomenclature used in vertical machining;
- d. Demonstrate safety practices related to vertical machining centers;
- e. Set-up and program operation of vertical machine;
- f. Demonstrate proper machining of objects;
- g. Create program using machine controllers software, and cycles;
- h. Set-up and utilize three dimensional digitizer; and,
- i. Maintain vertical machine.

Module Outline:

- I. Describe Vertical Machining Process and Safety
  - A. Describe History of Vertical Machining
    - 1. Describe proper use of various machines
  - B. Describe Theory of Operation
    - 1. Describe open and closed loop systems
    - 2. Describe various oil and air requirements
    - 3. Describe how vertical machines function
  - C. Describe Nomenclature Used in Vertical Machining
    - 1. Describe common tools used to:
      - a. Mill
      - b. Single point thread
      - c. Drill
      - d. Single point bore
      - e. Tap
      - f. Reaming
    - 2. Describe solid and collet type tool holders
  - D. Demonstrate Safety Practices Related to Vertical Machining Centers
    - 1. Demonstrate operating safety practices, including:
      - a. Safety door interlocks
      - b. Machining vise loading and unloading
      - c. Power box interlocks
      - d. Machine coolant disposal
      - e. Tool loading and unloading
    - 2. Describe/identify personal safety equipment
- II. Describe Vertical Machining Functions

A. Describe Controller Functions, including:
   1. Power meter
   2. Automatic mode
   3. Key lock
   4. Emergency stop button
   5. Option switches
   6. Manual modes:
      a. Command mode
      b. MDI mode
   7. Rapid travel over ride
   8. Single step mode (Block-To-Block)
   9. Feed rate override
   10. Jog mode
   11. Spindle speed override
   12. Spindle On/Off
   13. Axis selector
   14. Slide hold
   15. Increment of movement selector
   16. Coolant 1 and 2 On/Off
   17. Tool In/Out
   18. Start button
   19. Turret clockwise (CW) and turret counterclockwise (CCW)
   20. Start function

III. Set-Up and Program Operation of Vertical Machine

A. Describe machine tool limitations, including:
   1. Number of possible tools
   2. Limits in X,Y and Z axes
   3. Maximum spindle speed and horsepower
   4. Memory size in controller
   5. Fast feed rate
   6. Oil and air requirements
   7. Rapid positioning rate
   8. Communication systems

B. Perform basic machine set-up
   1. Check oil and air supply
   2. Set tool changer numbers
   3. Turn power on
   4. Mount machine vise on machine table
   5. Set machine home position
   6. Indicate vise to within specified tolerances
   7. Load tools into proper tool holders
   8. Load part into vise
   9. Load tools into tool carousel
      a. Load tools using spindle
      b. Load tools directly into carousel

- C. Set part home
    - 1. Set part home using edge finder
    - 2. Set part home using test indicator and gauge block
    - 3. Set part home from tooling ball using fixture offsets
- D. Set tool length offsets
    - 1. Set tool length offsets using work piece
    - 2. Set tool length offsets using gauge block
    - 3. Set tool length offsets using electronic probe
    - 4. Set tool length offsets using keyboard commands
    - 5. Modify length and diameter offsets using tool page editor.
    - 6. Upload and download tool information to storage
- E. Load program
    - 1. Upload and download programs using RS-232 interface
    - 2. Upload and download programs using local area network
- F. Edit program for machine tool
    - 1. Edit program at machine tool using editor in controller
    - 2. Edit program using DOS and Windows editors
- G. Create program without CAD/CAM for common machine operations using machine controllers software to include:
    - 1. Proper use of cutter compensation
    - 2. Fixed cycles
    - 3. Fixed sub-routines
    - 4. Sub-routines (loops)
    - 5. Fixture offsets
    - 6. Trouble shoot and repair problems in programs
    - 7. Use machine verification options if available

IV. Demonstrate Machining of Objects on Vertical Machining Center

- A. Machine objects, including:
    - 1. Outside contours
    - 2. Pockets
    - 3. Drilled holes
    - 4. Drill and tapped holes
        - a. Rigid tapping
        - b. Compression tapping
    - 5. Single point boring
    - 6. Reaming
    - 7. Single point thread, internal and external
- B. Set-up three dimensional digitizer and machine model
    - 1. Mount model on machine table
    - 2. Install 3-dimensional digitizing unit
    - 3. Establish communications with computer
    - 4. Define grid pattern and feed rate required for given tolerances
    - 5. Set part home
    - 6. Digitize model
    - 7. Process digital data for machining

    8. Machine new model with program created from digitizer

C. Create work piece using 4th- and 5th-axes
    1. Mount, connect and indicate 4th- and 5th-axes attachment
    2. Set-tooling
    3. Machine work piece
    4. Remove 4th- and 5th-axes attachment

D. Maintain vertical machine
    1. Mix coolant
    2. Determine need for coolant change
    3. Change coolant
    4. Clean coolant tank
    5. Clean machine
    6. Change oil filters
    7. Add lubricating fluid
    8. Add hydraulic fluid
    9. Dispose of coolant and oils per EPA regulations

TLD-H2-LE/SA
Program and Operate CNC Milling Machine and Machining Center
Attachment 2: MASTER Laboratory Exercise/Self-Assessment

Note to the Instructor:

Because of the wide variety of CNC machining centers and CNC mills available, student laboratory and assessment activities must be developed by the instructor for his or her particular laboratory equipment. All laboratory exercises and student assessments should be "hands on" which stress machine safety and assess the student's mastery of each of the lesson objectives.

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    - a. No loose clothing, including ties;
    - b. Long hair properly stowed;
    - c. No jewelry;
    - d. Hard, closed-toe shoes;
    - e. Eye protection (safety glasses); and,
    - f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

TLD-H3-HO
Program and Operate CNC Lathe
Attachment 1: MASTER Handout

Objectives:

Upon completion of this module the student will be able to:

- a. Describe history of horizontal turning centers;
- b. Describe theory of operation;
- c. Describe nomenclature used in horizontal turning centers;
- d. Demonstrate safety practices related to horizontal turning centers;
- e. Set-up and program operation of horizontal turning centers;
- f. Demonstrate proper machining of objects;
- g. Create program using machine controllers software; and,
- h. Maintain horizontal turning centers.

Module Outline:

- I. Explain CNC Turning Process, Equipment and Safety
  - A. Describe CNC turning process
    - 1. Describe history of CNC turning
    - 2. Describe use of various turning machines
  - B. Describe theory of operation
    - 1. Describe open and closed loop systems
    - 2. Describe various oil and air requirements
    - 3. Describe how turning centers function
  - C. Describe nomenclature used in CNC turning
    - 1. Describe and identify common tools used to:
      - a. Turn
      - b. Drill
      - c. Groove
      - d. Face
      - e. Bore
      - f. Single point thread
      - g. Tap
    - 2. Describe and identify work holding devices used in turning, including:
      - a. 2-jaw chucks
      - b. 3-jaw chuck
      - c. 4-jaw chucks
      - d. Soft jaw chucks
      - e. Bar feed attachments
      - f. Collets
      - g. Centers

    - 3. Select proper cutting inserts relative to:
        - a. Roughing
        - b. Finishing
        - c. Threading
        - d. Different types of materials
  - D. Demonstrate safety practices related to CNC turning centers
    - 1. Demonstrate operating safety practices, including:
        - a. Safety door interlocks
        - b. Power box interlocks
        - c. Tool loading and unloading
        - d. Loading and unloading work holding devices
        - e. Machine coolant disposal
    - 2. Describe/identify personal safety equipment
- II. Describe CNC Turning Center
  - A. Describe controller functions, including:
    - 1. Power meter
    - 2. Option switches
    - 3. Key lock
    - 4. Emergency stop button
    - 5. Rapid travel override
    - 6. Feed rate override
    - 7. Spindle speed override
    - 8. Axis selector
    - 9. Increment of movement selector
    - 10. Slide hold
    - 11. Start function
  - B. Describe keyboard functions, including:
    - 1. Automatic mode
    - 2. Manual MDI mode
    - 3. Single step mode (block-to-block)
    - 4. Jog mode
    - 5. Spindle on/off
    - 6. Coolant on/off
    - 7. Tool turret clockwise (CW) and tool turret counterclockwise (CCW)
- III. Set-Up and Program Operation of CNC Turning Center
  - A. Describe machine tool limitations, including:
    - 1. Number of possible tools
    - 2. Maximum spindle speed and horsepower
    - 3. Fast feed rate
    - 4. Rapid positioning rate
    - 5. Limits in X and Z axes
    - 6. Memory size in controller
    - 7. Oil and air requirements
    - 8. Communication systems

- B. Perform basic machine set-up
    - 1. Check oil and air supply
    - 2. Turn power on
    - 3. Set machine home position
    - 4. Load tools into proper tool holders
    - 5. Load tools into tool carousel
    - 6. Set tool changer numbers
    - 7. Mount work piece into chuck
    - 8. Indicate work piece within specified tolerances
- C. Set tool length offsets
    - 1. Set tool length offsets using work piece
    - 2. Set tool length offsets using keyboard commands
    - 3. Modify length and diameter offsets using tool page editor
    - 4. Modify length and diameter offsets using keyboard
    - 5. Upload and download tool information to storage
- D. Load program
    - 1. Upload and download programs using RS-232 interface
    - 2. Upload and download programs using local area network
- E. Edit program for machine tool
    - 1. Edit program at machine tool using editor in controller
    - 2. Edit program using DOS and Windows editors

IV. Create Program Without CAD/CAM for Common Machine Operations Using Machine Controllers Software to include:
- A. Proper use of cutter compensation
- B. Fixed cycles
- C. Fixed sub-routines
- D. Sub-routines (loops)
- E. Fixture offsets
- F. Trouble shoot and repair problems in programs
- G. Use machine verification options if available

V. Create Program for Common Machine Operations
- A. Use machine controller editor
- B. Use DOS editor
- C. Use Windows editor

VI. Demonstrate Machining of Objects on CNC Turning Center
- A. Machine objects, including:
    - 1. External and internal contouring
    - 2. External and internal grooving
    - 3. Drill and tapped holes
    - 4. Single point boring
    - 5. Reaming
    - 6. Single point thread internal and external
    - 7. Facing operations
    - 8. Turning tapers
- B. Maintain turning center

1. Mix coolant
2. Determine need for coolant change
3. Change coolant
4. Clean coolant tank
5. Clean machine
6. Change oil filters
7. Add lubricating fluid
8. Add hydraulic fluid
9. Dispose of coolant and oils per EPA regulations

TLD-H3-LE/SA
Program and Operate CNC Lathe
Attachment 2: MASTER Laboratory Exercise/Self-Assessment

Note to the Instructor:

Because of the wide variety of CNC machining centers and CNC mills available, student laboratory and assessment activities must be developed by the instructor for his or her particular laboratory equipment. All laboratory exercises and student assessments should be "hands on" which stress machine safety and assess the student's mastery of each of the lesson objectives.

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and,
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

TLD-H4-HO
Use Computer-Aided Drafting (CAD) System
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

- a. Create geometry using CAD system;
- b. Create 3-D solid models;
- c. Interconvert CAD and accepted drawing exchange formats;
- d. Configure CAD system parameters; and,
- e. Use peripheral devices.

Module Outline:

- I. Identify System Requirements
  - A. Hardware present and available
  - B. Software present and available
  - C. Equipment currently available
    - 1. Monitors
    - 2. CPU
    - 3. Keyboards
    - 4. Mouse
  - D. Peripheral devices available
    - 1. Printer
    - 2. Plotters
    - 3. LCD
    - 4. Digitizer
- II. Access and Maneuver Within CAD System
  - A. Use basic DOS commands
    - 1. Copy
    - 2. Move
    - 3. Delete
    - 4. List files
    - 5. Make directory
    - 6. Change directory
    - 7. Root directory
  - B. Initiate graphics editor
    - 1. Open existing files
    - 2. Creating new files
    - 3. Save/Save As files
    - 4. Q Saves files
    - 5. Quitting a graphic session
    - 6. Ending a graphic session

- C. Use various disk drives
- D. Use command line
- E. Use graphics area
- F. Use graphics cursor
- G. Use screen menus and submenus
- H. Use status and coordinate display line
- I. Use pull-down menus
- J. Use cursor menu
- K. Use keyboard
  - 1. Control keys
  - 2. Function keys
  - 3. Special keys
  - 4. Arrow keys
  - 5. Numeric value keys

III. Create Geometry Using CAD System

- A. Use utility and services commands
  - 1. Help
  - 2. New
  - 3. Open
  - 4. Save
  - 5. Exit
  - 6. Config
  - 7. About
  - 8. Status
  - 9. Limits
  - 10. Units
  - 11. Tablet
  - 12. Reinit
  - 13. Menu
  - 14. Compile
  - 15. Files
  - 16. Audit
  - 17. Recover
  - 18. Multiple
  - 19. Time
  - 20. Setvar
- B. Use the entity draw commands
  - 1. Line
  - 2. Point
  - 3. Circle
  - 4. Arc
  - 5. Trace
  - 6. Pline
  - 7. Polygon
  - 8. Doughnut

    9. Ellipse
    10. Sketch
    11. Solid
    12. Text
    13. D text
    14. Style

C. Use the edit and inquiry commands
    1. Grips
    2. Erase
    3. Copy
    4. Move
    5. Rotate
    6. Scale
    7. Mirror
    8. Stretch
    9. Array
    10. Change
    11. Pdedit
    12. Break
    13. Trim
    14. Extend
    15. Fillet
    16. Chamfer
    17. Offset
    18. Divide
    19. Measure
    20. Pedit
    21. Explode
    22. U/undo
    23. Redo
    24. List
    25. Dblist
    26. 10
    27. Dist
    28. Area

D. Use the display control commands
    1. Model space
    2. Paper space
    3. Viewports
    4. Regeneration
    5. Redraw
    6. Zoom
    7. Pan
    8. View
    9. Mview

   10. Redraw all
   11. Regen all
   12. Fill Qtext
   13. RegenAuto
   14. Dragmode
   15. Blipmode
   16. Viewers

E. Use the entity properties commands
   1. Layer
   2. DDLmodes
   3. DDEmodes
   4. Color
   5. Linetype
   6. LtScale

F. Use the drawing aids commands
   1. DDRmodes
   2. Snap
   3. Grid
   4. Ortho
   5. UCS
   6. DDUCS
   7. Ulsicon
   8. Object snap
   9. DDOsnap
   10. Osnap
   11. Aperture

G. Use the blocks and attributes commands
   1. Block
   2. DDinsert
   3. Insert
   4. Minsert
   5. Wblock
   6. Attributes
   7. DDATTDEF
   8. ATTDEF
   9. ATTDISP
   10. ATTEDIT
   11. DDATTE
   12. DDATTEXT
   13. ATTEXT

H. Use the cross-section and pattern filling commands
   1. BHATCH
   2. HATCH
   3. BPOLY
   4. Hatching system variables

IV. Dimensioning Geometry Using CAD System
    A. DIM and DIM I
    B. Associative dimensioning
        1. Terms
        2. Variables
        3. Styles
        4. Points
        5. Model/Paper space
    C. Dimension styles
        1. Override
        2. Restore
        3. Save
        4. Variables
        5. Stylenames
    D. Dimension variables
        1. Style
        2. Scaling
        3. Color
        4. Dimension line
        5. Extension line
        6. Arrows
        7. Text location
        8. Text format
        9. Features
        10. Colors
    E. Dimensioning geometry commands
        1. Linear
        2. Angular
        3. Diameter
        4. Radius
        5. Center marks and lines
        6. Ordinate
    F. Dimension editing
        1. Home text
        2. New text
        3. Oblique
        4. TEDIT
        5. Trotate
        6. Update
    G. Dimension utility
        1. Exit
        2. Leader
        3. Redraw
        4. Status
        5. Styles

    - 6. Undo
- V. Use Peripheral Devices
  - A. Printers
  - B. Plotters
    - 1. CMDDIM system variable
    - 2. Plot
      - a. Devices and defaults
      - b. Pen parameters
      - c. Additional parameters
      - d. Paper size and orientation
      - e. Scale
      - f. Rotation
      - g. Origin
      - h. Plot preview
  - C. Liquid crystal displays
  - D. Overhead projectors
  - E. Digitizer tablets
- VI. Interconvert CAD and Accepted Drawing Exchange Formats
  - A. Post Script Support
    - 1. PSOUT
    - 2. PSIN
    - 3. PSFILL
  - B. Slide shows
    - 1. MSLIDE
    - 2. VSLIDE
    - 3. Filmroll
  - C. Drawing interchange file (ASCII or Binary)
    - 1. DXFIIN
    - 2. DXFOUT
    - 3. DXBIN
  - D. Initial graphic exchange specification
    - 1. IGESIN
    - 2. IGESOUT

TLD-H5-HO
Create 3-D Solid Models
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Access and maneuver within a CAD system;
b. Create 3-D solid geometry models;
c. Dimension 3-D geometry;
d. Display commands to generate prototype borders;
e. Display commands to control drawing representation on the screen;
f. Display commands used to generate and manipulate viewports;
g. Setting commands to assist with 3-D geometry;
h. Layer commands to place entities into specified layer options;
i. Use isometric geometry commands;
j. Use 3-D surface and object commands;
k. Use utility to manage files;
l. Use utility commands to generate slides, script files, and access external commands of the system;
m. Use keyboard to manipulate function keys, special keys, control, and special character keys;
n. Use presentation graphics and rendering commands;
o. Use solid commands to generate 3-D solid model geometry;
p. Use 3-D solid modifiers commands;
q. Use solid 3-D inquiry commands;
r. Use solid 3-D representation commands;
s. Use solid 3-D utility commands;
t. Use LISP programs to generate 3-D solid model geometry;
u. Use Application Programming Interface (API) functions;
v. Use bonus 3-D solid feature commands; and,
w. Use CAD system to digitize paper drawings.

Module Outline:

I. Access and Maneuver Within a CAD System
    A. Use Disk Operating System commands
    B. Use the initial graphics editor within a CAD system
II. Create 3-D Solid Geometry Models
    A. Use the blocks and attributed commands
        1. Block
        2. Insert
        3. DDInsert
        4. MInset

5. WBlock
6. 3-DBlock
7. Attributes
8. DDATTDEF
9. ATTDEF
10. ATTDISP
11. ATTEDIT
12. DDATTE
13. DDATTEXT
14. ATTEXT

III. Dimension 3-D Geometry
A. Dim and Dim1
B. Associative dimensioning drawing commands
   1. Linear
   2. Angular
   3. Diameter
   4. Radius
   5. Ordinate
   6. Aligned
   7. Baseline
   8. Center
   9. Continue
   10. Vertical
   11. Horizontal
   12. Rotated

C. Dimension style command
   1. Override
   2. Restore
   3. Save
   4. Variable
   5. Style name

D. Dimension editing commands
   1. Hometext
   2. Newtext
   3. Oblique
   4. Tedit
   5. Trotate
   6. Update

E. Dimension utility commands
   1. Exit
   2. Leader
   3. Redraw
   4. Status
   5. Style
   6. Undo

- F. Dimension variable commands
    1. DIMALT
    2. DIMALTD
    3. DIMALTF
    4. DIMAPOST
    5. DIMASO
    6. DIMAZ
    7. DIMBLK
    8. DIMCEN
    9. DIMCLRD
    10. DIMCLRE
    11. DIMCLRT
    12. DIMDLE
    13. DIMDLI
    14. DIMEXE
    15. DIMEXO
    16. DIMGAP
    17. DIMLFAC
    18. DIMLIM
    19. DIMPOST
    20. DIMRND
    21. DIMSAH
    22. DIMSCALE
    23. DIMSE1
    24. DIMSE2
    25. DIMSHO
    26. DIMTAD
    27. DIMTFAC
    28. DIMTIH
    29. DIMTIX
    30. DIMTM
    31. DIMTOFL
    32. DIMTOH
    33. DIMTOL
    34. DIMTP
    35. DIMTSZ
    36. DIMTVP
    37. DIMTXT
    38. DIMZIN

- IV. Display Commands to Generate Prototype Borders
  - A. View
  - B. Layout
  - C. MVSetup
- V. Display Commands to Control Drawing Representation on the Screen
  - A. View

- B. DView
- C. DView Slide Bar
- D. Plan
- E. Vpoint
- F. Shade
- G. Zoom
- H. Redraw
- I. Pan
- J. Hide
- K. Viewports
- L. REGEN
- M. REDRAWALL
- N. REGENALL
- O. REGENAUTO
- P. VIEWERS
- Q. FILL

VI. Display Commands Used to Generate and Manipulate Viewports
- A. MView
- B. On
- C. Off
- D. HidePlot
- E. Fit
- F. MView
- G. MSpace
- H. PSpace
- I. TileMode
- J. VPlayer

VII. Setting Commands to Assist With 3-D Geometry
- A. DDEMODES
- B. DDRMODES
- C. APERTURE
- D. AXIS
- E. BLIPS
- F. COLOR
- G. DRAGMODE
- H. ELEVATION
- I. GRID
- J. LINETYPE
- K. LIMITS
- L. LTSCALE
- M. OSNAP
- N. QTEXT
- O. SETVARIABLE
- P. SNAP
- Q. STYLE

- R. TABLET
- S. UCS
- T. UCSICON
- U. DDUCS
- V. DDOSNAP
- W. GRIPS
- X. DDGRIPS
- Y. UNITS

VIII. Layer Commands to Place Entities into Specified Layer Options
- A. New layer
- B. Current layer
- C. Rename
- D. On and off
- E. Freeze and thaw
- F. Lock and unlock
- G. Set color
- H. Set linetype
- I. Filters
- J. DDLMODES

IX. Use Isometric Geometry Commands
- A. Snap
- B. Style
- C. Isometric
- D. Ellipse
- E. Isometric circle

X. Use 3-D Surface and Object Commands
- A. 3-D surface
  - 1. Edgesurf
  - 2. Rulesurf
  - 3. RevSurf
  - 4. TabSurf
  - 5. SurfTab1
  - 6. SurfTab2
  - 7. PEdit
  - 8. 3-DFace
  - 9. 3-DMesh
  - 10. PFace
  - 11. 3-DPoly
- B. 3-D objects
  - 1. 3-D box
  - 2. Pyramid
  - 3. Wedge
  - 4. Dome
  - 5. Sphere
  - 6. Cone

    - 7. Torus
    - 8. Dish
    - 9. Mesh

- XI. Use Utility to Manage Files
  - A. Audit
  - B. DXF/DFB
  - C. DXFIN
  - D. DXFOUT
  - E. DXBIN
  - F. IGES
  - G. IGESIN
  - H. IGESOUT
  - I. PURGE
- XII. Use Utility Commands to Generate Slides, Script Files, and Access External Commands of the System
  - A. Slide files
    - 1. MSlide
    - 2. VSlide
    - 3. Redraw
  - B. Script files
    - 1. Script
    - 2. RScript
    - 3. Resume
    - 4. Delay
    - 5. Graphscr
    - 6. Textscr
  - C. External commands
    - 1. Delete
    - 2. Directory
    - 3. Edit
    - 4. Type
    - 5. Shell
- XIII. Use Keyboard to Manipulate Function Keys, Special Keys, Control, and Special Character Keys
  - A. Function keys
    - 1. F1
    - 2. F6
    - 3. F7
    - 4. F8
    - 5. F9
    - 6. F10
  - B. Special keys
    - 1. Ctrl "C"
    - 2. Ctrl "B"
    - 3. Ctrl "Q"

        4. Ctrl "G"
        5. Ctrl "D"
        6. Ctrl "E"
        7. Ctrl "T"
        8. Ctrl "V"
        9. Ctrl "X"
        10. Ctrl "Q"
    C. Control and special characteristics
        1. % %d
        2. % %c
        3. % %o
        4. % %p
        5. % %u
        6. % %nnn
        7. %%%
XIV. Use Presentation Graphics and Rendering Commands
    A. Light
    B. VLight
    C. Camera
    D. VCamera
    E. Scene
    F. FilmRoll
    G. Open
    H. Quit
    I. Shading
    J. PlanView
    K. WireFrame
    L. Fast Shade
    M. Full Shade
    N. Replay
    O. Replay all
    P. Record
    Q. Hard Copy
XV. Use Solid Commands to Generate 3-D Solid Model Geometry
    A. SOLBOX
    B. SOLBOX (cube option)
    C. SOLCONE
    D. SOLCYL
    E. SOLSPHERE
    F. SOLTORUS
    G. SOLWEDGE
    H. SOLEXTRUDE
    I. SOLREVOLVE
    J. SOLIDIFY
XV1. Use 3-D Solid Modifiers Commands

- A. SOLINT
- B. SOLSUB
- C. SOLUNION
- D. SOLSEP
- E. SOLCUT
- F. SOLCHAM
- G. SOLFILL
- H. SOLCHP
- I. SOLMOVE

XVII. Use Solid 3-D Inquiry Commands
- A. LLIST
- B. LMASSP
- C. LAREA
- D. LINTERF

XVIII. Use Solid 3-D Representation Commands
- A. SOLMESH
- B. SOLWIRE
- C. SOLFEAT
- D. SOLPROF
- E. SOLSECT
- F. SOLHPAT
- G. SOLHSIZE
- H. SOLHANGLE

XIX. Use Solid 3-D Utility Commands
- A. SOLIN
- B. SOLOUT
- C. SOLMAT
- D. SOLPURGE
- E. SOLUCS
- F. SOLVAR
- G. UNLOAD

XX. Use LISP Programs to Generate 3-D Solid Model Geometry
- A. SOLMAINT
- B. WBLKSOL
- C. HOLE
- D. STLSUP

XXI. Use Application Programming Interface (API) Functions
- A. TUTOR
- B. ASM
- C. DRILL
- D. DESIGN
- E. LAYOUT
- F. SYMMETRY
- G. OFFSOL

XXII. Use Bonus 3-D Solid Feature Commands

- A. SOLSTLOUT
- B. SOLVIEW
- C. AMELINK

XXIII. Use CAD System to Digitize Paper Drawings

- A. Tablet mode
- B. Tablet on/off
- C. Tablet calibration
- D. Tablet configuration

TLD-H6-HO
Use Computer-Aided Manufacturing (CAM) System
Attachment 1: MASTER Handout

Objectives:

Upon completion of this unit the student will be able to:

1. Access CAD program options; and,
2. Create basic geometric entities.

Module Outline:

- I. Access CAD Program Options
    - A. Explain the configuration of CAD/CAM software
        - 1. Explain configuration of:
            - a File and path names
            - b. Installation, including DOS and Windows
            - c. Configure software
            - d. Interaction of files between each other
        - 2. Describe the "flow" process of CAD/CAM
    - B. Access CAD software
        - 1. Access CAD software, including AutoCAD and CadKey, to:
            - a. Create basic 2-dimensional designs
            - b. Create 3-dimension designs
            - c. Dimension designs to be used as drawings
            - d. Create title blocks and borders for prints
            - e. Print drawings
            - f. Plot drawings
            - g. Create general and local drawing notes and tolerances
        - 2. Describe various file conversion formats
        - 3. Import and export designs using conversions, including:
            - a. IGES
            - b. CADL
            - c. DXF
            - d. STL
    - C. Access CAM software
        - 1. Load existing design
        - 2. Import and export design files from various file format standards, including:
            - a. IGES
            - b. DXF
            - c. CADL
            - d. STL
        - 3. Save design files to "permanent" memory

        4. Access CAD section of CAM software to create
            a. Create basic 2-dimensional designs
            b. Create 3-dimension designs
            c. Dimension designs to be used as drawings
            d. Create title blocks and borders for prints
            e. Print drawings
            f. Plot drawings
            g. Create general and local drawing notes and tolerances

II. Create Basic Geometric Entities
    A. Create basic geometric entities, including:
        1. Points
        2. Fillets
        3. Lines
        4. Splines
        5. Arcs
        6. Chamfers
        7. Circles
        8. Letters including various machinable fonts
    B. Dimension completed designs to create detailed drawings
    C. Transform geometric entities using CAD commands
        1. Transform geometric entities, including:
            a. Mirror entities
            b. Rotate entities
            c. Scale complete entities using single scale option
            d. Translate using move and copy options
            e. Offset single and grouped geometric entities
            f. Use group function to effect multiple entities simultaneously
            g. Use result function to effect group movements
    D. Set menu selections to:
        1. View planes
        2. Construction planes
        3. Color choices
    E. Use Delete command:
        1. Use Delete commands, including:
            a. Chained and duplicate entities
            b. Exclusive entities (only)
            c. Inclusive entities (all)
            d. Enclosed in window
            e. Intersecting window
    F. Execute screen and display functions
        1. Use screen and display functions to:
            a. List screen statistics
            b. Display entity endpoints
            c. Clear group and result color designation

        - d. Change colors of entities
        - e. Display window
        - f. Un-zoom display
        - g. Change levels of entities
        - h. Fit entities to screen
        - i. Set various view ports
        - j. Refresh screen
        - k. Change views
        - l. Set active levels
        - m. Change entities between levels
        - m. Set screen center "pan"
        - n. Initialize display "clear"
        - o. Rotate display
- G. Use analyze function
    - 1. Use analyze function to interpret:
        - a. Point descriptions
        - b. Single entity information
        - c. Locations of entities
        - d. Distance between points
        - e. Area calculations
        - f. Calculation of angles

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

TOOL AND DIE MAKER .... skilled workers who produce tools, dies, and special guiding and holding devices that are used in machining.

	Duties	Tasks												
A	Practice Safety	A-1 Follow safety manuals and all safety regulations/ requirements	A-2 Maintain safe equipment and machinery	A-3 Use safe operating procedures for hand and machine tools	A-4 Maintain a clean and safe work environment	A-5 Use safe material handling practices	A-6 Consult and apply MSDS for hazards of various materials							
B	Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Perform basic algebraic operations	B-3 Use basic geometric principles	B-4 Perform basic trigonometric functions	B-5 Use and apply Cartesian Coordinate System								
C	Interpret Engineering Drawings and Related Documents	C-1 Interpret and understand basic layout/types of drawings	C-2 Interpret, review, and apply blueprint notes, dimensions, and tolerances	C-3 Use and apply Geometric Dimensioning and Tolerancing (GD&T)	C-4 Demonstrate traditional mechanical drafting and sketching techniques	C-5 Understand and use quality systems								
D	Demonstrate Knowledge of Manufacturing Materials	D-1 Identify materials with desired properties	D-2 Identify materials and processes to produce a part	D-3 Discuss classification systems for metal										
E	Measure/ Inspect	E-1 Understand metrology terms	E-2 Select measurement tools	E-3 Measure with hand held instruments	E-4 Eliminate measurement variables	E-5 Measure/inspect using surface plate and accessories	E-6 Inspect using stationary equipment							
F	Demonstrate Knowledge of Manufacturing Processes	F-1 Discuss metal cutting and metal cutting tools	F-2 Operate metal saws	F-3 Operate drill presses and tooling	F-4 Operate engine and turret lathes and tooling	F-5 Operate vertical and horizontal mills and tooling	F-6 Operate precision grinders	F-7 Operate heat treating equipment and processes	F-8 Operate sheet metal equipment	F-9 Operate welding equipment and processes	F-10 Estimate time required/ cost to produce a part			
G	Use Computers	G-1 Use computer operating systems	G-2 Understand computer terminology	G-3 Use file management systems	G-4 Install and use software packages									
H	Perform CAD/ CAM and CNC Programming Tasks	H-1 Discuss fundamentals of CNC machines and controls	H-2 Program and operate CNC milling machine and machining center	H-3 Program and operate CNC lathe	H-4 Use Computer-Aided Drafting (CAD) system	H-5 Create 3-D solid models	H-6 Use Computer-Aided Manufacturing (CAM) system							
I	Perform Tool and Die Making Operations	I-1 Discuss basic types and functions of jigs and fixtures	I-2 Utilize concepts of jig and fixture design	I-3 Demonstrate understanding of different types of industrial dies	I-4 Utilize basic die theory	I-5 Utilize principles of die design	I-6 Perform tool and die repair	I-7 Demonstrate tool and die making skills						
J	Operate Electrical Discharge Machine (EDM)	J-1 Discuss fundamentals of EDM	J-2 Setup and operate conventional sinker EDM	J-3 Program, setup, and operate CNC sinker EDM and EDM drill	J-4 Program, setup, and operate CNC wire EDM									

TLD-I1-HO
Discuss Basic Types and Functions of Jigs and Fixtures
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Distinguish between jigs and fixtures;
b. Discuss boring and drill jigs;
c. Discuss open and closed (box) jigs;
d. Discuss the various names used to identify jig types; and,
e. Discuss the various types and functions of fixtures.

Module Outline:

I. Distinguish Between Jigs and Fixtures and Discuss Need and Characteristics of Each
II. Discuss Various Applications of Jigs and Fixtures
    A. External-machining
    B. Internal-machining
    C. Non-machining
III. Identify Two General Classes of Jigs
    A. Boring jigs
    B. Drill jigs
IV. Discuss Types of Open Jigs
    A. Template jigs
    B. Plate jigs
    C. Table jigs
    D. Sandwich jigs
    E. Angle-plate jigs
V. Discuss Types of Closed Jigs
    A. Box, or tumble, jigs
    B. Channel jigs
    C. Leaf jigs
VI. Discuss Types of Jigs Which Can Be Either Open or Closed
    A. Indexing, or rotary, jigs
    B. Trunnion jigs
    C. Pump jigs
    D. Multi-station jigs
VII. Discuss Types and Functions of Fixtures
    A. Plate fixtures
    B. Angle-plate fixtures
    C. Vise-jaw fixtures
    D. Indexing fixtures

  E. Multi-station fixtures
  F. Profiling fixtures
VIII. Discuss Classification of Fixtures by Machine Type or Operation
IX. Discuss Modular Fixturing
  A. Sub-plate systems
  B. "T"-slot systems
  C. Dowel-pin systems

TLD-I2-HO
Utilize Concepts of Jig and Fixture Design
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Identify basic components of jigs and fixtures;
b. Discuss supporting and locating principles;
c. Discuss clamping and workholding principles; and,
d. Discuss basic construction principles.

Module Outline:

I. Generally Discuss the Following Components of Jigs and Fixtures
    A. Tool bodies and plates (or bases)
    B. Locators
    C. Clamping or locking devices
    D. Bushings or guides
    E. Supports
    F. Keys
    G. Feet or legs
II. Define and Discuss Supporting and Locating Principles
    A. Referencing
    B. Repeatability
    C. Locator position
    D. Tool tolerance (relative to part tolerance)
    E. Foolproofing
    F. The twelve planes of movement ("degrees of freedom")
    G. The three forms of location: plane, concentric, and radial
    H. External and internal locating
III. Discuss the Primary Types of Supports
    A. Solid
    B. Adjustable
    C. Equalizing
IV. Discuss Locator Types
    A. Locating pins
    B. Nesting locators
    C. Vee locators
    D. Fixed-stop locators
    E. Adjustable locators
    F. Sight locators
    G. Spring-loaded devices
V. Discuss Clamping and Workholding Principles

  A. The role of clamps
  B. Tool forces
  C. Clamping forces
  D. Position of the clamps
VI. Discuss Types of Clamps
  A. Strap clamps
  B. Screw clamps
  C. Swing and hook clamps
  D. Edge clamps
  E. Wedge clamps
  F. Cam-action clamps
  G. Toggle-action clamps
  H. Power clamping (general discussion)
VII. Discuss Basic Construction Principles
  A. Tool bodies
  B. Blocks
  C. Bushings
  D. Fastening devices

Rules of Conduct

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2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and,
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

TLD-I3-HO
Demonstrate Understanding of Different Types of Industrial Dies
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Describe the operation of blanking or piercing dies;
b. Describe the operation of bending or forming dies;
c. Describe the operation of compound dies;
d. Describe the operation of progressive dies;
e. Describe the operation of draw dies;
f. Describe the operation of compression dies; and,
g. Describe the operation of combination dies.

Module Outline:

I. Describe the Operation of Cutting Dies
    A. Piercing dies
    B. Notching and slotting dies
    C. Horn-type (mandrel) cutting dies
    D. Blanking dies
    E. Trimming and shaving dies
    F. Cutoff dies
    G. Broaching dies
II. Describe Operation of Bending and Forming Dies
    A. V-dies
    B. U-dies
    C. Radius dies
    D. Offset dies
    E. Gooseneck dies
    F. Miscellaneous dies (Curling, bulging, beading, etc.)
III. Describe Operation of Compound Dies
    A. Blank-and-pierce dies
    B. Blank, pierce, and notch dies
    C. Trim-and-pierce dies
    D. Shave-and-pierce dies
    E. Broach, cutoff, and pierce dies
IV. Describe Operation of Draw Dies
V. Describe Operation of Compression Dies
    A. Sizing dies
    B. Swaging (swedging) dies
    C. Coining and embossing dies
    D. Extruding dies

- VI. Describe Operation of Combination Dies
    - A. Cutoff-and-form dies
    - B. Lance-and-form dies
    - C. Cutoff, form, and pierce dies
    - D. Blank, draw, form, and pierce dies
    - E. Pierce, blank, lance, and emboss dies
    - F. Cutoff, form, and curl dies
    - G. Blank and draw dies
- VII. Describe Operation of Progressive Dies

TLD-I3-LA
Demonstrate Understanding of Different Types of Industrial Dies
Attachment 2: MASTER Laboratory Aid

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and,
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

TLD-I4-HO
Utilize Basic Die Theory
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

- a. Discuss shearing action on metal (3 stages);
- b. Explain notch, pierce, pilot, form, and cut-off stations;
- c. Explain operation of die set to make piece part;
- d. Explain spring back in form dies;
- e. Explain bending action in V-form dies; and,
- f. Explain coining in dies.

Module Outline:

- I. Explain Operation of Die Set to Make Piece Part
- Ii. Discuss Critical Stages of Shearing Action on Metal
  - A. Plastic deformation
  - B. Penetration
  - C. Fracture
- III. Explain Cutting Operations
  - A. Blanking
  - B. Piercing
  - C. Notching
  - D. Lancing
  - E. Cutting off and parting
  - F. Trimming and Shaving
- IV. Discuss Bending Stresses
  - A. The neutral plane
  - B. The elastic limit of materials
  - C. Plastic deformation and flow
  - D. Springback
  - E. Bend allowance curve
- V. Explain Bending and Forming Operations
  - A. Bending
    - 1. V-bending
    - 2. U-bending
    - 3. L-bending
  - B. Forming
    - 1. Solid forming
    - 2. Pad type forming
    - 3. Miscellaneous methods (bulging, curling, coining and embossing)
  - C. Drawing

Rules of Conduct

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    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
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    e. Eye protection (safety glasses); and,
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

TLD-I5-HO
Utilize Principles of Die Design
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Identify components of die set;
b. Discuss materials of die components;
c. Calculate proper shut-height of die set;
d. Design stock strip layout;
e. Calculate blank length for developed parts;
f. Calculate cutting length of piece part;
g. Determine press tonnage requirements;
h. Calculate die progression;
i. Calculate stripping pressure;
j. Calculate slug clearance;
k. Calculate cutting clearance; and,
l. Calculate offset displacement.

Module Outline:

I. Identify Components of a Typical Die
    A. Die set
    B. Punch
    C. Punch plate or holder
    D. Die block
    E. Stripper
    F. Pilot
    G. Stock guide or back gage
    H. Stop
    I. Fasteners
II. Identify Components of a Typical Die Set
    A. Die shoe
    B. Guidepost
    C. Guidepost bushing
    D. Punch shoe
    E. Shank
    F. Flange and bolt slot
III. Discuss Stock Strip Design
    A. Determining feed direction
    B. Locating stations
    C. Using strip layouts for die design
    D. Calculation of die progression

IV. Discuss Shut Height of Die
  A. Definition
  B. Calculation
  C. Determining stop block length
V. Discuss Punch Design
  A. Types
  B. Shear
  C. Material
VI. Discuss Design of Punch Plates
  A. Material
  B. Mounting
VII. Discuss Die Block Design
  A. Cutting clearances
    1. Definition and importance
    2. Calculation
      a. Type of cut
      b. Type of material
    3. Angular clearance
  B. Material
  C. Mounting
VIII. Discuss Cutting Force and Blanking Tonnage
  A. Determining the cutting area and length
  B. Shear or tensile strength of materials
  C. Calculation
IX. Discuss Stripper Design
  A. Types
  B. Stripping force
    1. Relationship with blanking tonnage
    2. Calculation
    3. Spring tables
    4. Rule of thumb for stripping bolts
  C. Knockouts
  D. Material
  E. Mounting
X. Discuss Pilot Design
  A. Methods
  B. Length and nose contour
  C. Material
XI. Discuss Design of Stock Guides and Back Gages
  A. Types
  B. Material
XII. Discuss Fasteners and Hardware
  A. Types
  B. Spacing

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    b. Long hair properly stowed;
    c. No jewelry;
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    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

TLD-I6-HO
Perform Tool and Die Repair
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

- a. Disassemble and assemble die set, jig, or fixture;
- b. Visually inspect components for damage;
- c. Determine method of repairing/sharpening;
- d. Determine material for replacement parts; and,
- e. Manufacture replacement parts.

Module Outline:

- I. Discuss Safety in the Die Shop
  - A. Proper die handling and transport
  - B. Safety in the machine shop
- II. Discuss Die Life
  - A. Punch life
  - B. Die block life
  - C. Characteristic cutting wear
  - D. Excessive wear
- III. Discuss Inspection of Die Components
  - A. Identify and inspect component parts
  - B. Inspection of piece part
- IV. Discuss Disassembly of Die
  - A. Removal and organization of component parts
  - B. Cleaning component parts
- V. Discuss Repair of Damaged Parts
  - A. Sharpening
    - 1. Amount of material to remove
    - 2. Procedures and techniques
  - B. Replacement
    - 1. Material
    - 2. Construction
- VI. Discuss Assembly of Die Set
  - A. Cleaning and deburring component parts
  - B. Mounting procedures
  - C. Checking clearances, depths, stop blocks, and shut-heights
- VII. Documentation
  - A. Maintenance work orders
  - B. Die records
  - C. Preventive maintenance plan
  - D. Inspection tags

Rules of Conduct

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3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and,
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

TLD-I7-HO
Demonstrate Tool and Die Making Skills
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Identify component parts from tool blueprint
b. Determine material / purchased part requirements
c. Utilize tool making procedures to make and assemble component parts
d. Demonstrate mounting and operation of die set in press machine
e. Inspect operation of tooling and piece part for accuracy

Module Outline:

I. Handout the Tool Blueprint and Discuss
II. Discuss Acquisition of Material and Purchased Components
III. Discuss Tool Making Procedures
IV. Discuss Mounting Procedures
V. Discuss Mounting and Operation of Die Set in Press Machine

Rules of Conduct

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   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

TOOL AND DIE MAKER .... skilled workers who produce tools, dies, and special guiding and holding devices that are used in machining.

	Duties	**Tasks**												
A	Practice Safety	A-1 Follow safety manuals and all safety regulations/ requirements	A-2 Maintain safe equipment and machinery	A-3 Use safe operating procedures for hand and machine tools	A-4 Maintain a clean and safe work environment	A-5 Use safe material handling practices	A-6 Consult and apply MSDS for hazards of various materials							
B	Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Perform basic algebraic operations	B-3 Use basic geometric principles	B-4 Perform basic trigonometric functions	B-5 Use and apply Cartesian Coordinate System								
C	Interpret Engineering Drawings and Related Documents	C-1 Interpret and understand basic layout/types of drawings	C-2 Interpret, review, and apply blueprint notes, dimensions, and tolerances	C-3 Use and apply Geometric Dimensioning and Tolerancing (GD&T)	C-4 Demonstrate traditional mechanical drafting and sketching techniques	C-5 Understand and use quality systems								
D	Demonstrate Knowledge of Manufacturing Materials	D-1 Identify materials with desired properties	D-2 Identify materials and processes to produce a part	D-3 Discuss classification systems for metal										
E	Measure/ Inspect	E-1 Understand metrology terms	E-2 Select measurement tools	E-3 Measure with hand held instruments	E-4 Eliminate measurement variables	E-5 Measure/inspect using surface plate and accessories	E-6 Inspect using stationary equipment							
F	Demonstrate Knowledge of Manufacturing Processes	F-1 Discuss metal cutting and metal cutting tools	F-2 Operate metal saws	F-3 Operate drill presses and tooling	F-4 Operate engine and turret lathes and tooling	F-5 Operate vertical and horizontal mills and tooling	F-6 Operate precision grinders	F-7 Operate heat treating equipment and processes	F-8 Operate sheet metal equipment	F-9 Operate welding equipment and processes	F-10 Estimate time required/ cost to produce a part			
G	Use Computers	G-1 Use computer operating systems	G-2 Understand computer terminology	G-3 Use file management systems	G-4 Install and use software packages									
H	Perform CAD/ CAM and CNC Programming Tasks	H-1 Discuss fundamentals of CNC machines and controls	H-2 Program and operate CNC milling machine and machining center	H-3 Program and operate CNC lathe	H-4 Use Computer-Aided Drafting (CAD) system	H-5 Create 3-D solid models	H-6 Use Computer-Aided Manufacturing (CAM) system							
I	Perform Tool and Die Making Operations	I-1 Discuss basic types and functions of jigs and fixtures	I-2 Utilize concepts of jig and fixture design	I-3 Demonstrate understanding of different types of industrial dies	I-4 Utilize basic die theory	I-5 Utilize principles of die design	I-6 Perform tool and die repair	I-7 Demonstrate tool and die making skills						
J	Operate Electrical Discharge Machine (EDM)	J-1 Discuss fundamentals of EDM	J-2 Setup and operate conventional sinker EDM	J-3 Program, setup, and operate CNC sinker EDM and EDM drill	J-4 Program, setup, and operate CNC wire EDM									

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TLD-J1-HO
Discuss Fundamentals of EDM
Attachment 1: MASTER Handout

Objectives:

Upon completion of this unit the student will be able to:

- a. Explain the principles of Electrical Discharge Machining (EDM);
- b. Discuss the advantages, limitations, and applications of EDM;
- c. Discuss EDM safety;
- d. Name and state the purpose of the main components of the EDM process; and,
- e. Explain the types of EDM processes.

Module Outline:

- I. Explain the Principles of Electrical Discharge Machining (EDM)
- II. Discuss the Advantages, Limitations, and Applications of EDM
- III. Discuss EDM Safety
- IV. Name and State the Purpose of the Main Components of the EDM Process
  - A. Electrode
    - 1. Characteristics
    - 2. Types
    - 3. Materials used
  - B. Dielectric fluid
    - 1. Functions
    - 2. Characteristics
    - 3. Methods of circulating
  - C. Servomechanism
  - D. Power supply
  - E. Machine Control Unit
- V. Explain the Types of EDM Processes
  - A. Sinker (plunge or ram type) EDM
  - B. Traveling wire EDM

Rules of Conduct

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3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and,
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

TLD-J2-HO
Setup and Operate Conventional Sinker EDM
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:
- a. Identify the components of the sinker EDM process;
- b. Explain the terms and principles of the sinker EDM process;
- c. Discuss electrode design and construction;
- d. Practice safety with sinker EDM;
- e. Set-up and operate sinker EDM; and,
- f. Practice preventive maintenance measures for the sinker EDM

Module Outline:

- I. Review the Components of the Sinker EDM Process
  - A. Electrode
  - B. Dielectric fluid
  - C. Servomechanism
  - D. Power supply
  - E. Machine Control Unit
- II. Explain the Principles and Terms of the Sinker EDM Process
  - A. Amperage
  - B. Frequency
  - C. Voltage (gap and striking)
  - D. Capacitance
  - E. Polarity
  - F. Ionization
  - G. Overcut
  - H. Swarf
  - I. Flushing
  - J. Surface Finish
  - K. Dither or vibration
  - L. Metal-removal rate
  - M. On-time
  - N. Off-time
- III. Discuss Electrode Design and Construction
  - A. Material selection
    - 1. Workpiece material
    - 2. Wear characteristics
    - 3. Machinability
    - 4. Cost
  - B. Accuracy

C. Surface finish
D. Coolant Flushing

IV. Discuss Sinker EDM Safety

V. Discuss Set-Up and Operation of EDM
A. Workpiece set-up
B. Tooling
C. Locating principles
D. Power supply controls
E. Machine tool controls
F. Cutting procedures and adjustments
G. Rough and finish cuts

VI. Practice Preventive Maintenance Measures for the Sinker EDM

Rules of Conduct

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2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and,
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

TLD-J3-HO
Program, Setup, and Operate CNC Sinker EDM and EDM Drill
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Review the components of the sinker EDM process;
b. Discuss sinker EDM safety;
c. Discuss applications and benefits of sinker EDM (specifically in Tool and Die);
d. Discuss CNC programming of CNC sinker EDM;
e. Discuss set-up and operation of CNC sinker EDM; and,
f. Practice preventive maintenance measures for the CNC sinker EDM.

Module Outline:

I. Review the Components of the Sinker EDM Process
  A. Electrode
  B. Dielectric fluid
  C. Servomechanism
  D. Power supply
  E. Machine Control Unit
II. Discuss Sinker EDM Safety
III. Discuss Applications and Benefits of Sinker EDM (specifically in Tool and Die)
IV. Discuss CNC Programming of CNC Sinker EDM
  A. Coordinate Words (X, Y, U, V, Z, I, J)
  B. Basic "G" codes
  C. Basic "M" codes
  D. Program origin point
  E. Simple programming
  F. CANNED cycles, subprograms, and macros
V. Discuss Set-Up and Operation of CNC Sinker EDM
  A. Workpiece set-up and requirements
  B. Electrode
  C. Tooling
  D. Locating principles
  E. Power supply controls
  F. Machine tool controls
  G. Program operation
    1. Manual Data Input (MDI)
    2. DNC and transfer
    3. Program edit

        - 4. **Memory storage**
    - H. **Cutting procedures and adjustments**
    - I. **Starter and pilot holes**
    - J. **Rough and finish cuts**
- VI. Practice Preventive Maintenance Measures for the CNC Sinker EDM

Rules of Conduct

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2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and,
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

TLD-J4-HO
Program, Setup, and Operate CNC Wire EDM
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Review the components of the CNC wire EDM process;
b. Explain the wire EDM process;
c. Identify the three types of Wire EDM;
d. Discuss applications and benefits of wire EDM (specifically in Tool and Die);
e. Explain the principles and terms of the wire EDM process;
f. Discuss wire EDM safety;
g. Discuss CNC programming of wire EDM;
h. Discuss set-up and operation of wire EDM; and,
i. Practice preventive maintenance measures for the wire EDM.

Module Outline:

I. Review the Components of the CNC Wire EDM Process
    A. Electrode
    B. Dielectric fluid
    C. Servomechanism
    D. Power supply
    E. Machine Control Unit
II. Explain the Wire EDM Process
III. Identify the Three Types of Wire EDM
    A. Two axis
    B. Simultaneous four axis
    C. Independent four axis
IV. Discuss Applications and Benefits of Wire EDM (specifically in Tool and Die)
V. Explain the Principles and Terms of the Wire EDM Process
    A. Kerf
    B. Overcut
    C. On-time/Off-time
    D. Flushing
    E. Flow rate
    F. Amperage
    G. Voltage
    H. Current
    I. Polarity
    J. Dielectric fluid resistivity
    K. Wire tension

- L. Wire feed

VI. Discuss Wire EDM Safety

VII. Discuss CNC Programming of Wire EDM
- A. Coordinate words (X, Y, U, V, Z, I, J)
- B. Basic "G" codes
- C. Basic "M" codes
- D. Program origin point
- E. Simple two-axis programming
- F. CANNED cycles, subprograms, and macros
- G. Four-axis programming

VIII. Discuss Set-Up and Operation of Wire EDM
- A. Workpiece set-up and requirements
- B. Electrode (wire)
- C. Tooling
- D. Locating principles
- E. Power supply controls
- F. Machine tool controls
- G. Program operation
    1. Manual Data Input (MDI)
    2. DNC and transfer
    3. Program edit
    4. Memory storage
- H. Cutting procedures and adjustments
- I. Starter and pilot holes
- J. Rough and finish cuts

IX. Practice Preventive Maintenance Measures for the Wire EDM

TLD-J4-LA
Program, Setup, and Operate CNC Wire EDM
Attachment 2: MASTER Laboratory Aid

Rules of Conduct

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4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and,
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.